TUBERCULOSIS IN INDIA

a sample survey

1955-1958

INDIAN COUNCIL OF MEDICAL RESEARCH
NEW DELHI

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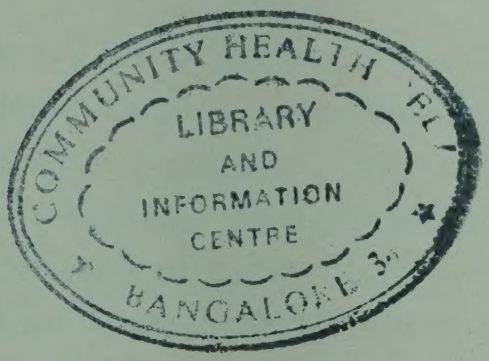
TUBERCULOSIS IN INDIA

SPECIAL REPORT SERIES NO. 34.



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FOREWORD

TUBERCULOSIS takes a heavy toll of life in India and is one of those important public health problems which the Government of India would like to deal with as expeditiously as possible. Large schemes for tuberculosis control are being undertaken and it is, therefore, very necessary to have knowledge of the prevalence of tuberculosis in our country so that we may be in a position to assess scientifically the impression the control measures make on that problem. With this object in view, an epidemiological investigation has been carried out and this report contains the results of that investigation. The investigation has been carried out at an opportune moment, and not a day too early, and it is of interest to note that an effort of such a magnitude is not known to have been attempted earlier.

The preliminary report of this investigation was presented at the International Tuberculosis Conference in Delhi in January, 1957, and it created great interest among visiting workers from other countries. They suggested that such work should be undertaken in other countries of the East in order to ascertain the position of tuberculosis in them. I am sure, tuberculosis workers, not only in India but in other parts of the world as well, are looking forward to the publication of this report with interest.

I am glad that the Indian Council of Medical Research has been able to undertake this investigation for which the Government of India has provided the Council with necessary funds.

I would like to congratulate those who have participated in this labour and have made the appearance of this report possible and would commend the report to all who are interested in tuberculosis.

New Delhi,
1st May, 1959.

D.P. KARMARKAR
MINISTER FOR HEALTH
GOVERNMENT OF INDIA.

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PREFACE

तमसो मा ज्योतिर्गमय

"From darkness lead us to light"—(SHATPATH BRĀHMAN)

THE above quotation seems to be apt in presenting this report on the Sample Survey on Tuberculosis in India. Even in the recent past precise knowledge of the prevalence of tuberculosis in India was lacking and this was a serious handicap in the working out of large scale plans for the control of this disease. Attempts were made to assess the problem by individual tuberculosis workers by limited surveys, but these were like stray rays of light in total darkness and formed only rough guides for planning. The Five Year Plans demanded more accurate data on the extent and nature of our tuberculosis problem than what was available and this was one of the urgent reasons for undertaking this survey. This survey in fact is the first major attempt at a systematic assessment of the magnitude of the tuberculosis problem in India.

The present survey was limited to pulmonary tuberculosis as this is considered to be the most important form of tuberculosis in the country from the epidemiological and public health points of view. Areas around six centres, viz., Calcutta, Delhi, Hyderabad, Madanapalle, Patna and Trivandrum, which had mobile miniature *x*-ray units, were selected for survey. These zones together account for about 40 per cent of the population of the country. Within each zone the population to be surveyed was selected on a sampling basis, due consideration having been given to both urban and rural areas. This report relates to the survey covering six cities, 30 towns and 151 villages. The number of persons *x*-rayed was 290,758.

The survey posed many technical and organisational problems. The technical problems such as deciding on the criteria for diagnosing tuberculosis were taken up by the Tuberculosis Sub-Committee of the Indian Council of Medical Research, which also called in special experts when necessary. In the course of the survey, this committee set up two special sub committees, one to handle the questions arising in the planning and execution of the survey and the other to evolve suitable methods for using the *x*-ray and bacteriological findings to arrive at reliable estimates of the prevalence of the disease.

On the organisational side, the main problem was to provide additional facilities for those survey units which were not adequately equipped for large-scale miniature radiography and laboratory examinations. Further, all the centres did not have adequate staff with experience in carrying out mass surveys. In three centres, viz., Calcutta, Delhi and Madanapalle, a nucleus staff was readily available while

in the other three centres, viz., Hyderabad, Patna and Trivandrum, the bulk of the staff required for survey had to be recruited and trained. The officers-in-charge for the Hyderabad, Trivandrum and Patna zones were given training in Madanapalle or Delhi. The training of the other local staff was the responsibility of the officers-in-charge in the different zones.

The survey had to be operated on a zonal basis with each centre taking complete responsibility for the preliminary reading of the *x*-ray films and for bacteriological examinations. Additional laboratory facilities had to be provided to some of the centres. It was realised that it would be possible to take the mobile vans only to villages situated sufficiently close to motorable roads. In order that the survey may be extended to areas which would thus be excluded, it was necessary to secure portable *x*-ray units. The World Health Organisation offered two *x*-ray outfits for this purpose, but these arrived in India too late to be used in all the six zones, nor were they portable enough to be transported far into inaccessible areas. These units were, however, used to cover the inaccessible blocks of Calcutta city and are now being used in two zones for surveying a sample of the inaccessible villages included in the original sample. As the mobile *x*-ray vans of the Hyderabad centre were found to be too heavy to reach even the "accessible" villages arrangements were made to transfer to this centre a smaller mobile *x*-ray unit from the Tuberculosis Centre, Madras.

The areas to be surveyed, being selected at random, were scattered all over each zone and sometimes more than 100 miles had to be covered for going from one selected area to another. It was, therefore, essential to make arrangements for placing adequate number of transport vehicles with each team. This became possible because of the timely help given by the UNICEF who loaned some of the reserve vehicles (jeeps and station wagons) they had for BCG Campaign.

The procuring and distribution of *x*-ray films had also to be handled expeditiously. Since adequate stock was not available in the country, immediate requirements had to be airlifted from foreign countries.

The finances for the survey were provided by the Government of India, who placed a special grant of Rs. 6 lakhs at the disposal of the Indian Council of Medical Research under whose auspices the survey was carried out. Though it has been possible to carry out the survey with this amount, the expenditure incurred cannot be taken as a standard for similar surveys. The salary of regular staff attached to each survey unit was paid by the organisation which was administratively controlling it. Only the special allowance for the field staff and the salary and allowances for extra staff employed were met by the Indian Council of Medical Research. The expenditure on the statistical tabulations and analysis, which would have been considerable, was also not met from this special grant, as existing staff and equipment of institutions participating in the survey were utilised for this purpose.

In a survey of this type where the sample selected is comparatively small it is essential to have a high coverage of the selected population. It was realised from the beginning that special efforts were to be made to secure the co-operation of the public. Our approach was such that it was possible in most of the zones to *x*-ray about 90 per cent of the sampled population. It must be emphasised that this high coverage has been achieved under very difficult conditions and by long and strenuous hours of work on the part of the field staff. To ensure full co-operation of the population, considerable spade-work had to be done both by the senior officials of the Government and the field workers. It would not have been possible for them to perform this important aspect of the work so successfully but for the excellent co-operation they received from all categories of Government officials, especially from the Directors of Health Services of the States and their district officers.

The survey was completed within the stipulated period of about two years. This made it possible to present a preliminary report about tuberculosis morbidity in the country at the International Tuberculosis Conference held in Delhi in January, 1957. While we are happy that such a sample survey could be carried out in a scientific manner in about two years' time at the cost indicated, a word of caution seems to be necessary for those who may think of undertaking similar surveys. The latitude given by the Indian Council of Medical Research and the Government of India to carry out this work on an emergency basis was partly responsible for the quick turn over. If normal administrative procedure were followed it was very likely the survey could have taken five years or more, with corresponding increased cost.

There can be no doubt that the present survey has more than justified the expenditure incurred on and the effort put into it. In addition to providing reliable data about the prevalence of pulmonary tuberculosis in the country the survey has also indicated the need for some reconsideration of the prevailing ideas on the epidemiology of tuberculosis in India. These are of great value in our planning tuberculosis control measures for the country. For example, contrary to prevailing notions the survey has shown that tuberculosis is prevalent in rural areas also almost to the same extent as in urban areas and as such anti-tuberculosis measures have to be extended to these areas before long. The survey has also been timely in giving data, which can provide the base line against which comparisons could be made in future in assessing the prevalence of tuberculosis. It was essential to secure this base line now, as far-reaching changes in the social and economic life are taking place in the country, and also large scale anti-tuberculosis measures are being introduced in its Five Year Plan programmes.

The survey was planned and supervised by the Tuberculosis Sub-Committee of the Indian Council of Medical Research and thanks are due to the Members of this Committee for the hard and heavy work they had put in during the course of the survey and the preparation of the report. Thanks are due to the Government of India for placing at the disposal of the Indian Council of Medical Research the necessary funds for the survey.

Special thanks are due to Dr. C. Chandrasekaran, Professor of Statistics, All-India Institute of Hygiene and Public Health, Calcutta, who was our statistical adviser and who has been mainly responsible for drawing up the detailed plans for the survey and for the analysis and presentation of the data as well as for the preparation of this report. He was assisted in this by the statisticians of the Tuberculosis Section of the Directorate General of Health Services, the Union Mission Tuberculosis Sanatorium, Arogyavaram (Madanapalle) and the New Delhi Tuberculosis Centre (Delhi).

Mention has already been made of the field staff who by their untiring efforts and commendable tact and patience completed the field work within the stipulated time and secured the co-operation of about 90 per cent of the population in the selected groups. Thanks are also due to the local Government agencies in the areas surveyed and the officials at the State and District Headquarters for the co-operation they had extended to the field teams. We have to thank the Directors of Statistics in the States of Bihar, Bombay, Hyderabad (now Andhra), Mysore and Travancore-Cochin (now Kerala) for their help in selecting the sample blocks to be surveyed within towns and cities in their States.

We are grateful to the various institutions for placing at our disposal the mobile *x*-ray units and other facilities with their experienced staff for carrying out the survey. Our thanks are due to the international agencies, W.H.O. and UNICEF, for providing additional equipment and transport vehicles needed for the survey. I take this opportunity to thank my staff in the Tuberculosis Section of the Directorate General of Health Services for the unstinted help they have given during the various phases of the survey and in the preparation of this report.

P.V. Benjamin
Adviser in Tuberculosis,
Government of India.

New Delhi,
31st March, 1959.

INTRODUCTION

Tuberculosis in India—general impressions

Tuberculosis was known to exist in India over two thousand years ago and the description of the disease, its symptoms and treatment in early Indian literature leaves no doubt as to the identity of the disease. But there was no indication whether it was confined only to certain isolated areas or whether its existence was widespread.

While there was no exact information available about the extent of the disease even in the recent past, there was enough evidence to believe that it has been widespread for a considerable time and is at present a major public health problem. This is specially so because conditions favourable to the spread of the disease such as poverty, inadequate or unbalanced nutrition, and overcrowding are only too common. The overcrowding in cities is well-known, the houses being clustered together and whole families having to live mostly in single or double room tenements. But even in rural areas, such living conditions are not uncommon as in most parts of the country, villages usually consist of clusters of houses built within a small area, even though there is plenty of open space around. Increased contact between urban and rural populations, because of improved communications and of industrialisation is also a contributing factor in the spread of tuberculosis to the rural areas. This is particularly so, as under Indian conditions workers from rural areas move temporarily to cities during the slack seasons in search of employment and return home periodically when agricultural operations demand their presence. It is also known that when workers from rural areas fall sick in cities, they try to return to the villages for recouping their health.

Data on the prevalence of pulmonary tuberculosis

Until recently information on the prevalence of the disease in different parts of the country has been meagre. The available data are reviewed below.

(*i*) *Mortality rate* is one of the criteria used for judging the seriousness of the tuberculosis problem in a country. This is not a reliable index in India as, apart from the fact that death registration is incomplete, accurate certification of the cause of death is not possible due to paucity of trained medical personnel. No attempt has therefore been made to present the available mortality statistics here.

(*ii*) *Morbidity rate* is another criterion used for assessing the tuberculosis problem. Facilities for accurate diagnosis and for the notification of the diagnosed cases do not exist at present in many parts of the country. For this reason notification statistics cannot also be cited with advantage. Some special investigations

on limited groups of population form the main source for providing a direct indication of the prevalence of tuberculosis.

During 1938-39 a population of 30,000 in Saidapet, a suburb of Madras (South India) was surveyed (Benjamin *et al* 1939). Here, a sample of the population was tuberculin tested and those who were strongly positive to tuberculin were *x*-rayed. This survey showed that at least in that part of the city, the tuberculosis prevalence rate was 2·3 per cent. Another survey in the urban areas of Serampore (Lal *et al* 1944) showed a morbidity of 7 per cent ; tubercle bacilli were demonstrated in 3 per cent of the population examined. In the absence of mass miniature *x*-ray equipment, these investigations were carried out with meagre *x*-ray facilities.

Since 1945, *x*-ray surveys have been carried out on a limited scale with the help of miniature *x*-ray equipment. The first of these was done in a military centre (Aspin, 1945); 6,000 persons were *x*-rayed, half of them Gurkha recruits and half labour unit personnel. This survey showed a morbidity of 1 per cent and 3·4 per cent among the Gurkha recruits and labour units respectively.

Further surveys with miniature *x*-rays of groups of population have been done during the last ten years in Delhi, Madras, Madanapalle and Trivandrum. These surveys showed morbidity rates varying from 1·2% to 2·5% (Frimodt-Moller, 1949, Sikand and Raj Narain, 1952, Phillip *et al* 1952, Hertzberg, 1952). The above surveys have all been in urban areas. In 1952, a rural population of 34,000 persons living in 175 villages around Madanapalle was also surveyed. The morbidity in this group was 0·42 per cent ; tubercle bacilli were demonstrated in 0·24 per cent (Frimodt-Moller *et al* 1952).

The above estimates of morbidity are based on investigations by individual workers. Moreover these studies, excepting the one at Madanapalle, were confined to special groups such as police force, medical students, nurses, college students, factory workers and displaced persons. Although these studies have, no doubt, given valuable information, yet they do not provide an adequate basis for estimating the incidence of tuberculosis in the general population.

(*iii*) *Infection rate.*—Tuberculin testing has long been recognised as one of the methods for estimating tuberculosis infection in a community and thereby providing an indirect measure of the prevalence of the disease. Tuberculosis workers in India had made extensive use of this method between 1930 and 1940. More recently, the results of country-wide tuberculin tests done in connection with the mass BCG Vaccination Campaign are available. These have shown that in the industrial cities about 75 per cent of the population become tuberculin positive by the age of fifteen. These have also shown that infection rate is generally higher in urban areas than in semi-urban and rural areas. But the differences in infection rates between the villages, towns and cities were not as well-marked as was expected. This was a matter which had to be studied further specially because it implied that the prevalence of the disease in small towns and rural areas may be much higher than was expected.

Need for adequate information

Till now, the planning of tuberculosis control measures had perforce to be based on the meagre information that was available. Since large scale Tuberculosis control measures were being introduced as part of the Five Year Plans, it was thought essential to secure additional data which could not only help in introducing control measures in areas and communities needing them most, but also to provide the base line for assessing the effectiveness of these measures in course of time. Without such data being made available now, the opportunity for such scientific assessment might be completely lost.

The question was : "How could the necessary data be secured expeditiously and economically ?" The Tuberculosis Sub-Committee of the Indian Council of Medical Research considered this question and decided that this objective could be achieved only by undertaking a sample survey in different parts of the country. While this matter was being discussed, the need for presenting reliable data on tuberculosis prevalence in India at the International Tuberculosis Conference held in New Delhi, early in 1957, made the need for such a survey even more urgent. The Government of India agreed to give a special grant to the Indian Council of Medical Research to undertake such a survey. The Tuberculosis Sub-Committee of the Indian Council of Medical Research drew up a detailed plan for the survey and undertook to carry it out under its supervision.

CHAPTER I

GENERAL CONSIDERATIONS IN THE PLANNING OF THE SURVEY

IN PLANNING this sample survey on the prevalence of pulmonary tuberculosis it was thought that the method of choice would be to supplement radiological findings with bacteriological examinations. The diagnostic examinations to be used and the population groups to be surveyed had to be determined largely from practical considerations. These considerations and the decisions made are discussed below :—

(*a*) DIAGNOSTIC EXAMINATIONS

A primary consideration in the planning of the survey was the diagnostic examinations to be used. It is usual in clinical practice to base the diagnosis of pulmonary tuberculosis on *x*-ray examination followed by repeated bacteriological examinations for demonstrating the presence of tubercle bacilli. In those cases, where a miniature *x*-ray has been taken first and this has shown doubtful or suspicious shadows, large *x*-rays or screening have been resorted to for confirmation. In an extensive survey as the one under consideration this detailed examination was not considered to be practicable as it involved repeated visits to populations scattered over wide areas. The actual operations in the field were therefore limited to (*i*) the taking of one miniature *x*-ray (70 mm.) and (*ii*) collection of sputum and laryngeal swab specimens for bacteriological examinations during a *single visit* from persons with suspicious *x*-rays.

The use of the miniature *x*-ray films would not only result in reducing the cost, but also in increasing the speed of the taking and reading of the *x*-ray pictures as compared to use of films of standard size. Inasmuch as there were reasons to believe that the loss of information resulting from the use of miniature films would be negligible (Yerushalmy 1947), the accuracy of the survey from the radiological point of view was not likely to suffer. In regard to bacteriological findings, it was realised from the very beginning that the inability to carry out repeated examinations would result in an under-estimation of the bacteriologically positive cases. While this was considered inevitable in view of the budgetary and personnel limitations under which the survey had to be planned, it was felt that the use of a single bacteriological examination could provide at least a definite lower limit to the number of active tuberculosis cases in the community.

(*b*) FORMATION OF ZONES

Because of the type of diagnostic examinations to be done in the survey only populations living in areas surrounding the tuberculosis centres with mass *x*-ray

units and facilities for bacteriological examination could be included. Four centres, *viz.*, Union Mission Tuberculosis Sanatorium, Madanapalle, and the Tuberculosis Centres at New Delhi, Patna and Trivandrum already had both these facilities. At two other centres *viz.*, All-India Institute of Hygiene and Public Health, Calcutta and Tuberculosis Centre, Hyderabad, mass *x*-ray units were available, but facilities for bacteriological examination had to be organised. A new centre was expected to be set up at Madras, with all facilities required for the survey. It was decided therefore to have the survey in areas around these seven centres and use the headquarters laboratory facilities at each centre for bacteriological work. These areas are referred to as *zones* in this report.

The spread of the zones around these centres had to be determined from practical considerations. In order to obtain valid estimates of disease prevalence it was necessary to ensure that as close to 100 per cent of the population selected for survey as possible should be *x*-rayed and be subjected to other examinations considered necessary. This was particularly important because the percentage of tuberculosis cases in the population was not likely to be more than 5 per cent. It was doubted whether such a high proportion of the populations included for survey would actually submit themselves to the necessary examinations unless the task was made easy for them. In particular, it was felt that the *x*-ray van should reach as close to the people as possible, so that they would not be required to travel long distances for being *x*-rayed. This involved moving the *x*-ray van over long distances and sometimes over bad or improvised roads, putting a limitation on the size of the zone to be formed round each centre. A further limitation was the consideration that bacteriological specimens had to be transported to headquarters well within a week of their collection. In view of these considerations areas within a radius of about 200 miles round the headquarters formed the zones included for the survey. Details of these zones are given in Table 1·1. The population included in these zones constituted 46 per cent of the population of the Indian Union. Since the Madras unit was not ready at the time when the survey started, this zone had to be excluded from the survey. Even so the six zones included in the survey covered 40 per cent of the population of the Union. The location of these zones is shown in Map. 1

(*c*) Population groups to be included

It was apparent from the outset that the present survey could not be expected to provide estimates of morbidity on a national basis. As stated above, only persons living in six zones could be taken up for the survey and at best, therefore, the survey could provide estimates only for the population of these zones. Specific population groups from each zone for which estimates of morbidity were required had also to be considered. Although zonal estimates would have been of interest, it was felt that differences in morbidity patterns, which could be used to understand the extent to which the disease is spread over the epidemiologically important

TABLE 1·1

Zones selected for survey

Name of zone	Areas included	Population (1951 Census)
Calcutta	Districts of West Bengal* south of the River Ganga and the districts of Mayurbhanj, Balasore and Keonjhar of Orissa State.	23,844,000
Delhi	Punjab, Pepsu and Delhi and districts of Saharanpur, Muzaffarnagar, Meerut, Bulandshahr, Aligarh and Mathura of Uttar Pradesh.	28,691,000
Hyderabad	Hyderabad State, and districts of Sholapur, Bijapur, Belgaum, Dharwar and Kanara of Bombay State.	25,377,000
Madanapalle	Districts of Andhra State south of River Krishna, Mysore State and North Arcot district of Madras State.	23,148,000
Madras	Madras State, excluding the districts of North Arcot, South Kanara, Malabar, Nilgiris and Tinnevelly.	23,610,000
Patna	Districts of Bihar State south of the River Ganga.	21,554,000 (approximate)
Trivandrum	Travancore-Cochin, Coorg, and districts of South Kanara, Malabar, Nilgiris, Tinnevelly of Madras State.	18,775,000

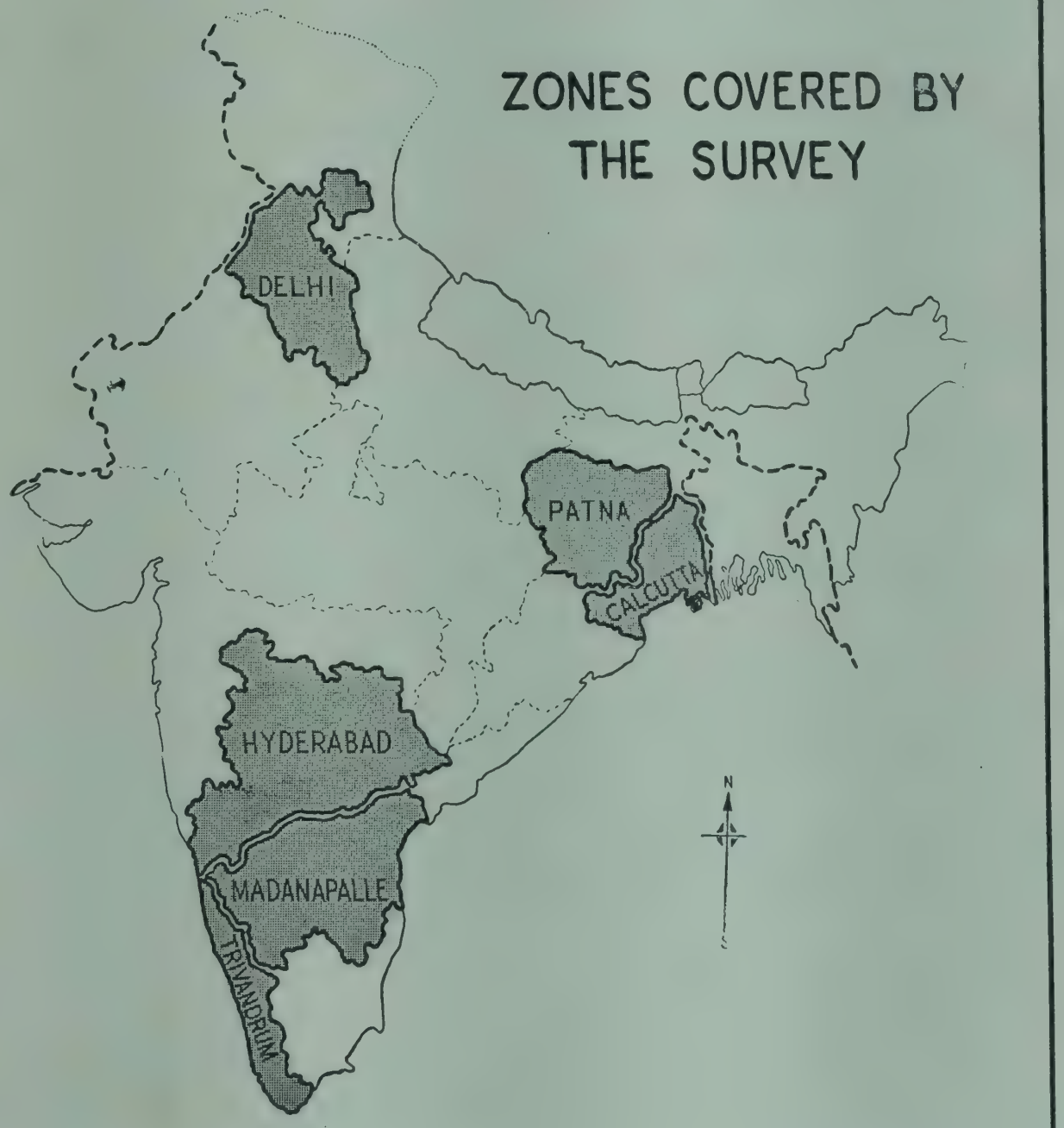
*States referred to are those prior to re-organisation.

cross-sections of the population such as urban or rural, were of even greater importance. Such information it was thought could be utilised for understanding the magnitude of the problem on a national basis, though the survey had to be restricted to a few zones. Hence the survey was designed primarily to estimate morbidity in certain cross-sections of the population, *viz.*, urban, semi-urban and rural. Differences in morbidity according to age and sex were also considered of importance.

Within each zone, it was decided therefore to confine attention to the populations living in (1) the largest city, (2) medium-sized towns—(population between 10,000 to 50,000) and (3) villages (population less than 5,000), the data of the 1951 census being used for this purpose. The population data for these groups are shown in Table 1·2. The three cross-sections included in the survey covered 80 to 90 per cent of the total population of a zone, the only exception being Trivandrum

MAP 1

SAMPLE SURVEY ON TUBERCULOSIS IN INDIA (1955-58,



zone where the proportion included was only 62 per cent. The lower figure for the Trivandrum zone was due to the relatively higher proportion of the population living in small towns of sizes between 5,000 and 10,000.

TABLE 1·2

Population in the city, medium-sized towns and villages in each zone.

Zone	Population (1951 Census)				Total population of the zone (1951 Census)	Percentage of population included from the zone.
	Largest city	Medium-sized towns.	Villages	Total		
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Calcutta	2,549,000	1,276,000	17,379,000	21,204,000	23,844,000	89
Delhi	1,191,000	1,752,000	20,138,000	23,081,000	28,691,000	80
Hyderabad	1,086,000	1,505,000	19,874,000	22,465,000	25,377,000	89
Madanapalle	779,000	1,805,000	17,837,000	20,421,000	23,148,000	88
Patna	283,000	655,000	16,883,000	17,821,000	21,554,000	83
Trivandrum	187,000	1,355,000	10,005,000	11,547,000	18,775,000	62

(*d*) OTHER CONSIDERATIONS

Two other considerations restricting the selection of groups to be surveyed had to be taken into account. One of these related to the exclusion of children under five years of age because of the difficulties of *x*-raying them in a standing position. The other related to the exclusion of "inaccessible" areas. It was not considered advisable to include rural populations living in places within half a mile of which the *x*-ray van could not be taken. Such villages were called "inaccessible". In urban areas, the *x*-ray van had to be taken still closer if the public had to co-operate in the survey. In some congested parts of the cities it was not possible to park the van within a reasonable distance from the areas selected for survey. These were also designated as "inaccessible" and could not be surveyed at the first instance. Arrangements were subsequently made to use portable *x*-ray units to survey at least some of these inaccessible areas. All the inaccessible areas in the cities have since been surveyed and the findings in these areas are included in this report. Those for inaccessible villages have been left out as the survey of such villages was still in progress at the time of writing this report.

CHAPTER II

PLAN OF SURVEY

(*a*) Sampling procedure

The accuracy with which estimates are obtained from a sample survey will depend on the size of the sample and the sampling procedure adopted. In the present survey which was the first of its kind in India the sampling procedure had to be kept extremely simple. It was also realised that as errors arising from the limitations of diagnostic techniques feasible under large scale field conditions would be considerable, it was not desirable either to aim at a low sampling error or adopt complicated sampling procedures to increase the efficiency of sampling. A coefficient of variation of 15 per cent for the estimates of morbidity in the three cross-sections of the population *viz.* village, medium-sized town and city within each zone was considered adequate for purposes of the present survey and in the absence of sufficient data on sampling variations, the sample size necessary for providing this desired level of accuracy was determined approximately.

The size of sample and the sampling procedure decided upon were as follows :

Cities.—The largest city of each zone was to be divided into blocks each containing about 800 to 1000 persons. About 30 to 40 blocks were to be selected at random for survey, the number of blocks chosen from a city being larger if the average population of the block was smaller.

Medium-sized towns.—Towns with populations 10,000 and above but below 50,000 were to be divided into two strata *viz.* (*i*) towns with populations of 10,000 and above but below 20,000 and (*ii*) towns with populations of 20,000 and above but below 50,000.

Four towns from the first stratum and two towns from the second were to be selected at random. Each town so selected was to be divided into blocks, each block containing between 500 to 750 persons. Ten per cent of the blocks from each selected town was to be chosen at random.

Villages.—In regard to the villages the decision as mentioned earlier was to leave out the inaccessible villages and to include for survey only those within half a mile of which the mass *x*-ray unit could be taken. As a list of accessible villages was not available, the following procedure was adopted which led to the selection of about 30 accessible villages from each zone according to a scheme of stratified proportionate random sampling.

Villages in each zone were stratified into three groups according to their populations in the 1951 census *viz.*, (*i*) below 500 (*ii*) 500 and above but below 2,000 and (*iii*) 2,000 and above but below 5,000. At the first instance 120 villages were

selected at random, the number selected from each of the above strata being proportionate to the total number of villages in them. The accessibility of these villages had to be ascertained preferably by actual field visits. From among the accessible villages in each stratum, a constant proportion was drawn randomly, this proportion being so adjusted as to give a selection of 30 villages from the entire zone. If the number of accessible villages among the 120 was below 30, a further sample of 80 villages was selected in the same manner as the original 120. Thirty accessible villages were to be selected from the accessible villages among the 200 (*i.e.* the original 120 plus the additional 80) adopting a procedure similar to that followed when only 120 villages had been selected.

All persons ordinarily residing in the blocks or villages so selected and aged 5 years and above were to be *x*-rayed. Such persons would henceforth be referred to as those *eligible for x-ray*.

It will be noticed from the above that the ultimate sampling unit was the eligible population in an entire block in the case of cities and towns, and in an entire village in rural areas. These units were considered desirable not only from the point of view of sampling efficiency but also to facilitate field work. There was less likelihood of suspicion and antagonism, particularly in the rural areas, if the entire population living within an area was selected for survey than if only a few households from it were included.

(*b*) Field procedure for *x*-ray

The field operations consisted of —

(*i*) marking out the block or village selected for survey ;

(*ii*) listing of the population in the selected block or village by means of a Household Schedule ; and

(*iii*) preparation of *x*-ray cards for those eligible for *x*-ray and *x*-ray operation.

In order to ensure uniformity, detailed instructions in regard to these operations were provided to the field staff through a Manual which is given as Appendix 1-A to this report. The salient points of these operations are given below :

(*i*) *Marking out blocks or villages selected for suvrey* : *Blocks.*—While the Central Office selected the towns and cities to be included in the sample, the selection of actual blocks to be surveyed within them had to be done in the field. In many of the cities and towns selected for survey information regarding the blocks into which they were divided for the 1951 census was expected to be locally available. As each of these blocks normally contained about 600 persons at the time of the 1951 census, it was thought that they could readily be used for sampling of blocks in the selected towns and cities.

Villages.—The village boundaries as used for the 1951 census were those applicable for administrative and revenue purposes and would cover not only the main village but also any hamlets attached to it. The village headman could usually give these boundaries and help in their identification. Except in the Trivandrum

zone, villages are usually compact and the marking out of their boundaries was not expected to take much time.

(*ii*) *Listing of population.*—The entire population residing in a block or village at the time of the survey had to be listed by means of a Household Schedule. A household for this purpose was defined as "a group of persons normally living together (in a dwelling unit) and having a common cooking arrangement". The Schedule contained information on (1) identifying particulars of the household and (2) sex, age etc. for every individual in the household. Against every name space was provided for recording the *x*-ray number, at the time of *x*-ray and in case a person was not *x*-rayed, the reasons for the same. In order to provide a rough indication of the economic status of the household, information regarding type of house was also to be entered in the Schedule under the three headings—hut, kutcha house and pucca house. In addition, the Schedule was designed to obtain information about tuberculous patients who were away from home in hospitals and sanatoria.

(*iii*) *Preparation of x-ray card.*—An *x*-ray card had to be filled for every person eligible for *x*-ray. This card carried information on the name, sex, age etc. of the individual. Space was provided in it for recording the *x*-ray number, which could be automatically photographed in the *x*-ray film and for recording radiological and bacteriological findings. Although there was a separate card for each individual, the cards for all the members of a household were to be kept together as members of a household generally came together for *x*-ray.

(*c*) Procedure for reading of *x*-ray films

(*i*) *Dual readings.*—As repeated bacteriological examinations were not possible in this survey, the interpretation of the *x*-ray films was a crucial factor in estimating the prevalence of the disease. The procedure adopted had to ensure that the errors in final diagnosis as made from the *x*-ray films would not be appreciable. That a single reading of the film could introduce large errors had been demonstrated in a number of studies (Yerushalmy, 1947) and in our test readings. These errors are of two types, *viz.*

(1) omission of 'true positives', *i.e.* tuberculous cases being diagnosed as non-tuberculous, and

(2) inclusion of 'false positives', *i.e.* non-tuberculous cases being diagnosed tuberculous.

The first of these *viz.* omission of 'true positives' could be progressively reduced by increasing the number of readers who would independently read each *x*-ray film and accepting as positives all cases marked out as tuberculous. The number of 'false positives' would also be increased by increasing the number of readers and following the above procedure. The question was to determine the number of independent readers to be used in the present survey. Using the estimates of the frequency of the two types of errors observed in other studies, it

appeared that the use of more than two independent readers was likely to result in the inclusion of progressively larger number of "false positives" without any appreciable diminution in the number of "true positives" missed. From the practical point of view also it was not possible to consider using more than two independent readers.

The large number of "false positives" which would be included by accepting the positive findings of both of the readers could be removed to a considerable extent with the help of a third interpretation of the films. The exact manner in which the third reading should be used for this purpose was to be developed later on when the results of the dual readings could be submitted to trial investigations. The results of such experiments and the final procedure adopted for using the third reading are discussed in Chapter IV.

(*ii*) X-*ray code*.—Each reader was required to read the films according to an *x*-ray code with four main headings namely :

(I) Type of pathology;
(II) Cavity;
(III) Impression regarding aetiology ; and
(IV) Calcification.

The first two groups would provide an objective and descriptive recording of the pathological findings without considering whether the pathology was of tuberculous origin or not. Group (III) was intended to give the impression of the reader, from the film, about the nature of pathology—whether tuberculous or not and the extent of activity, if tuberculous. Group (IV) was to record the absence or presence of calcification in the lung.

The details of the classifications under each group are given below :

I. Type of Pathology

1. Apparently normal.
2. Minimal parenchymal lesions.
3. Moderate Parenchymal lesions.
4. Extensive Parenchymal lesions.
5. Lobar pneumonia.
6. Atelectasis.
7. Fibrotic scar in lung.
8. Hilar adenitis.
9. Pleural scar.
10. Pleural effusion, small.
11. Pleural effusion, moderate or extensive.
12. Pneumothorax/Hydropneumothorax.
13. Cardio-vascular pathology.
14. Operated (Thoracoplasty, lung resection, etc.).
15. Special pathology.
16. Technical error.

II. Cavity

In every case with lung pathology an entry regarding cavity was to be made under one of the three headings, "present", "doubtful" or "not seen".

III. Impression regarding aetiology

The classifications under aetiology were defined as follows:

(*A*) *Probably non-tuberculous.*—Cases of suspected lung abscess, non-tuberculous pneumonia, bronchiectasis, congestion, tumours, hydatid cysts, cystic lung or any other non-tuberculous condition.

(*B*) *Probably tuberculous but inactive.*—Cases probably due to tuberculosis but which are not likely to excrete bacilli.

(*C*) *Probably tuberculous possibly active.*—Cases of tuberculous nature which may or may not excrete bacilli.

(*D*) *Probably tuberculous and active.*—Cases which most probably excrete tubercle bacilli.

(*E*) *Undecided.*—Atypical cases, or such cases which could equally well be caused by tuberculosis or by some other disease ; in short, such cases where the reader would refrain from committing himself to any special aetiology at that stage.

IV. Calcification

Presence or absence of definite calcified foci in the lung parenchyma or pleura, irrespective of whether any other pathology is present or not, was to be noted.

Detailed instructions for reading of *x*-ray films according to the above code were given in a Manual (Appendix 1-B).

It would be observed from the classification under aetiology that groups "*C*" and "*D*" were together intended to include all tuberculous conditions which were probably or definitely "active". These two groups were therefore particularly important for providing a measure of disease prevalence in the population *x*-rayed. The method used for supplementing the aetiological findings with those of bacteriology in order to obtain estimates of disease prevalence is discussed in Chapter IV.

(*d*) Procedure for bacteriological examination

Bacteriological examination was to be carried out in all cases which were considered by one or both of the two local readers as showing evidence of any type of pathology (not necessarily tuberculous) in the *x*-ray film. This liberal inclusion for bacteriological examination was intended to reduce errors of type (1), in the reading of *x*-rays, referred to earlier *viz.*, omission of true positives.

In view of the practical difficulty of making repeated visits to widely scattered areas the bacteriological examinations were to be based on material that could be

collected during one field visit. This consisted of :

1. Sputum (2 slides) for direct smear examination.
2. Sputum (2 tubes) for culture examination.
3. Laryngeal swab (2 tubes) for culture examination.

The centres were instructed to collect these specimens as soon as possible, after the *x*-ray work was over.

Except for the direct smear examination for which slides were made in the field laboratory, other examinations were to be carried out in the headquarters laboratory. In particular it was emphasised that inoculation of culture should be done indoors under the best conditions possible. Also the specimens were to be transported with great speed to headquarters for processing and examination. These precautions were taken to prevent contamination.

Details of the bacteriological procedure are given in the Manual prepared for the purpose (Appendix 1-C). Results of bacteriological examination, as soon as available, were to be entered in detail in the space provided in the *x*-ray cards.

CHAPTER III

FIELD WORK

(*a*) Field staff

The six centres entrusted with the survey in the various zones had already some staff which was doing similar work on a smaller scale. With this as nucleus, a team was built up at each centre to carry out the survey in the zone allotted to it. Newly recruited personnel were given training before they were sent to the field. The composition of an average team was as follows :

Medical Officer (Leader of the Team)	...	1
X-ray technicians	...	2
Bacteriologist or Senior Laboratory technician	...	1
Laboratory attendant	...	1
Enumerators	...	5
Drivers	...	4
General assistants	...	4
Cook	...	1

making a strength of nineteen members.

Apart from this regular staff local authorities made available the services of some of their public health workers for help in the survey in their respective areas. In some places it was found necessary to employ, on a purely temporary basis, a female worker to help the women coming for *x*-ray to stand in the correct position required for *x*-raying.

(*b*) Field operations

The actual survey work was preceded by a preliminary visit either by the leader of the team or a senior officer of the centre, often with State and local health officials, to the area proposed to be covered. At this visit the purpose of the survey was explained to influential persons in the area and their co-operation sought. Arrangements for the camping of the field staff were also made.

For the survey proper, the field unit was broken up into three teams—(*i*) the census team, (*ii*) the main *x*-ray team, (*iii*) the laboratory team, each visiting the area in that order.

(*i*) *Work of census and x-ray teams.*—The census team consisting of 4 or 5 enumerators and a general assistant reached the area 3 or 4 days in advance of the main *x*-ray team. With the help of the local administrative and public health staff they demarcated the area to be surveyed, numbered the houses (where this was not

already done) and completed the census. While enumerating the population they also informed the persons eligible for *x*-ray where and when they were expected to come for *x*-ray. A duplicate copy of the Household Schedule was also handed over to a responsible member of the household to facilitate identification of the individuals when they came for *x*-ray.

By the time the main *x*-ray team arrived the census would have been completed and *x*-ray cards for all those eligible made out by copying relevant information from the Household Schedule. Part of the census team stayed on to help the *x*-ray team in the survey work while the other part of the team was sent to the next area to start census there without loss of time.

Each person coming for *x*-ray was given his *x*-ray card after establishing his identity with the help of the duplicate Household Schedule. The *x*-ray number was stamped on this card as well as in the space provided for this purpose, against the name of the person in the register of Household Schedules. The *x*-ray cards were issued in such a manner that the number of persons waiting to be *x*-rayed at any time was of a manageable size. This was done to ensure that the *x*-rays were taken in the serial order corresponding to the *x*-ray numbers and to avoid any loss of cards or their exchange among the persons in the group. It was made known that persons living outside the selected area but desirous of getting *x*-rayed out of curiosity or need could also get *x*-rayed separately, free of charge, without being included in the survey programme. This was done to create goodwill among the local population as well as to avoid possibilities of impersonation.

(*ii*) *Hours of work.*—*X*-ray sessions were held at hours most convenient to the local population. In most places the team had to start work as early as 5 A.M. and the night sessions sometimes went on till near-midnight. Women and children were usually available during the day but for working men, specially in villages, the only hours of comparative leisure were in the early morning or late at night.

(*iii*) *Public response.*—At the first few sessions the attendance was high enough to keep the machines busy, nearly 70 per cent getting themselves *x*-rayed rather readily. It was usually the last 10 or 15 per cent that offered most resistance. Considerable effort had to be put in for persuading them to come for *x*-ray. Besides taking the help of influential persons in the locality the situation demanded a good deal of tact and patience on the part of almost all members of the team, particularly the leader of the team. As a result of their persistent efforts, all but a very small proportion of those physically present in the area have been *x*-rayed in most places. In general the response of the public was better in the villages than in the towns and cities. The average number of persons *x*-rayed per working day varied between 100 and 250 in the various zones. There were instances when over 400 persons were *x*-rayed in one day and others when a whole day was spent in getting only a handful of the unwilling ones to come for *x*-ray.

(*iv*) *Reading of x-rays and selection of cases for bacteriological examination.*—*X*-ray films were generally developed in the field to enable the medical officer who

was also one of the local readers (except in one zone) to read them and pick out cases needing bacteriological examination. At short intervals the films were sent through a messenger to the zonal headquarters for the second local reading. After both local readers had given their readings, lists showing the cases needing bacteriology were handed over to the laboratory team.

(*v*) *Work of laboratory team.* The laboratory team, consisting of the bacteriologist and an attendant, visited the area as soon as they obtained lists of persons needing bacteriological examination. They carried with them all material necessary for the purpose, including sterilised sputum cups, slides, chemicals, etc. On the first day they distributed sputum cups to persons who were to be bacteriologically examined asking them to collect a day's sputum in the cup and present it personally the next morning at an appointed place. When the person brought his sputum, the required number of laryngeal swabs were also taken from him. Direct smear slides were made on the spot and the material collected was immediately taken back to the headquarters laboratory for processing and examination. Unlike the *x*-ray team, the laboratory team had to visit headquarters after completing each area to avoid contamination in the specimens. Details of the bacteriological examinations done and the procedures followed are given in Chapter V of this report. In most areas it was possible to complete the bacteriological examination within a month of the *x*-ray.

The general pattern of field work described above had to be varied slightly from zone to zone and area to area to suit local conditions. But in all zones the field work has been completed under exacting conditions. The full team consisting of about 20 workers had to camp out for days together or spend considerable time in travelling from one village or town to another. They had to come across varying types of people with widely differing objections to the survey and persuade them to come for *x*-ray. Some interesting field experiences are given in Appendix 5.

(*c*) Time schedule

Due to various reasons the survey in all zones could not be started simultaneously. Some centres which had previous experience of this type of work could make an early start but others had problems of equipment and personnel and were rather late to start work in the field. Table 3·1 gives details of the time schedule of the *x*-ray survey in different zones.

The timing of the survey in the different areas within each zone was left to the discretion of the local team. Most centres preferred to complete the towns and villages before they took up the survey in the city. This was partly because it was felt that the survey in the villages and towns would prove easier than in the city. The timing of the survey in the villages and towns had also to be adjusted to seasonal factors specially because many roads became impassable for the *x*-ray van during the rainy season. Villages and towns within the same area were surveyed before the team moved to a different area. As can be seen from Table 3·1

TABLE 3·1

Time schedule of field work in different zones.

Zone	Period of work			Average speed of work : No. x-rayed per day	Average interval between x-ray and bacteriological examination		
	City	Towns	Villages		City	Towns	Villages
Calcutta	Dec. 1955-Nov. 1956 Jan. 1958-April 1958	Nov. 1956-May 1957 Nov. 1957-Jan. 1958	April 1958	125	2-3 weeks	4-5 weeks	4-5 weeks
Delhi	May 1956-July 1956 Aug. 1956-Sep. 1956 Oct. 1956-Dec. 1956	July 1955-Oct. 1955	July 1955-Oct. 1955 Dec. 1955-April 1956	240	1-2 weeks	1-2 weeks	1-2 weeks
Hyderabad	Jan.-April 1956 July-Sept. 1956	Oct. 1956-Jan. 1957 March-June 1957	Nov. 1956-Aug. 1957 Oct. 1957	125	2 weeks	2 months	3 months
Madanapalle	Nov. 1956-Dec. 1956 Jan. 1957-April 1957	Feb. 1956-March 1956 April 1956 May 1956-July 1956 Sep. 1956-Oct. 1956	Sep. 1955-Dec. 1955 Jan. 1956-Feb. 1956 March 1956 April 1956-May 1957	125	2 weeks	3 weeks	4 weeks
Patna	Aug. 1956-Dec. 1956 March 1958— April 1958	April 1956-July 1956 Jan. 1957-July 1957	March 1957— Aug. 1957 Sept. 1957	160	5 days	7 days	3 days
Trivandrum	Dec. 1956-May 1957	Dec. 1955 March 1956 July 1956 Sep. 1956 Nov. 1956	Dec. 1955-Nov. 1956	230	1-3 months	1 week- 2 months	1 day- 1 month

work had occasionally to be suspended. The major reason for stoppage of work was breakdown in the *x*-ray equipment except in the Delhi zone where floods held up the progress of work for nearly three months.

(*d*) Coverage of areas in different zones

Except Calcutta, all other centres found it possible to complete the survey in the three types of areas assigned to them, *viz.*, villages, towns and city. The geographical distributions of villages, towns and city surveyed in these five zones are given in the maps Nos. 2 to 6. In the Calcutta zone, due to special difficulties, it was not possible to complete the work in all the villages and towns. For purposes of this report, therefore, Calcutta zone includes only Calcutta city. The location of the blocks surveyed in each of the six cities included is given in the maps Nos. 7 to 12.

MAP 2: UNITS SURVEYED IN DELHI ZONE

MAP 3: # UNITS SURVEYED IN HYDERABAD ZONE

MAP 4 :

UNITS SURVEYED IN MADANAPALLE ZONE

MAP 5

UNITS SURVEYED IN PATNA ZONE

MAP 6

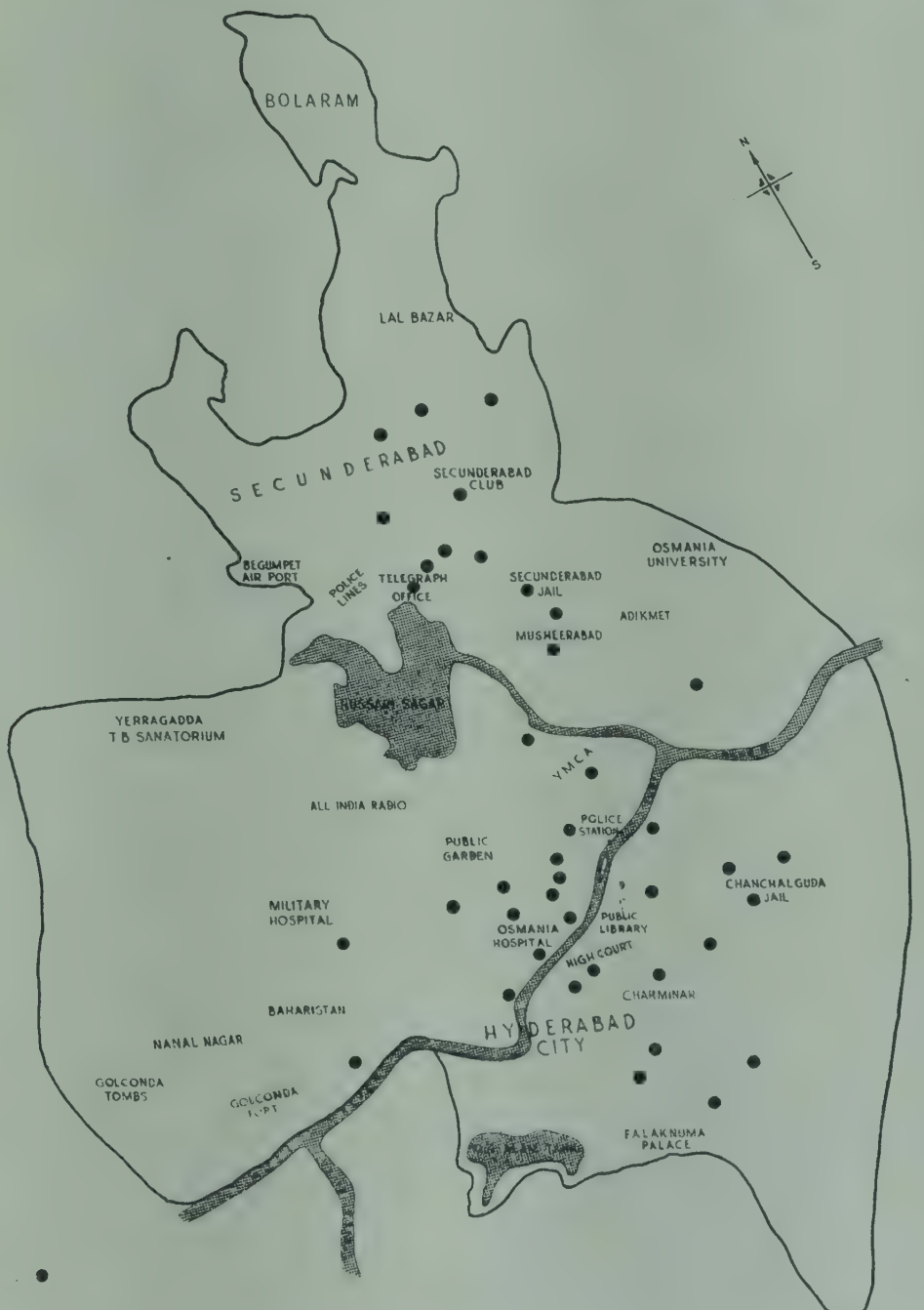
UNITS SURVEYED IN TRIVANDRUM ZONE

MAP 7: BLOCKS SURVEYED IN CALCUTTA CITY

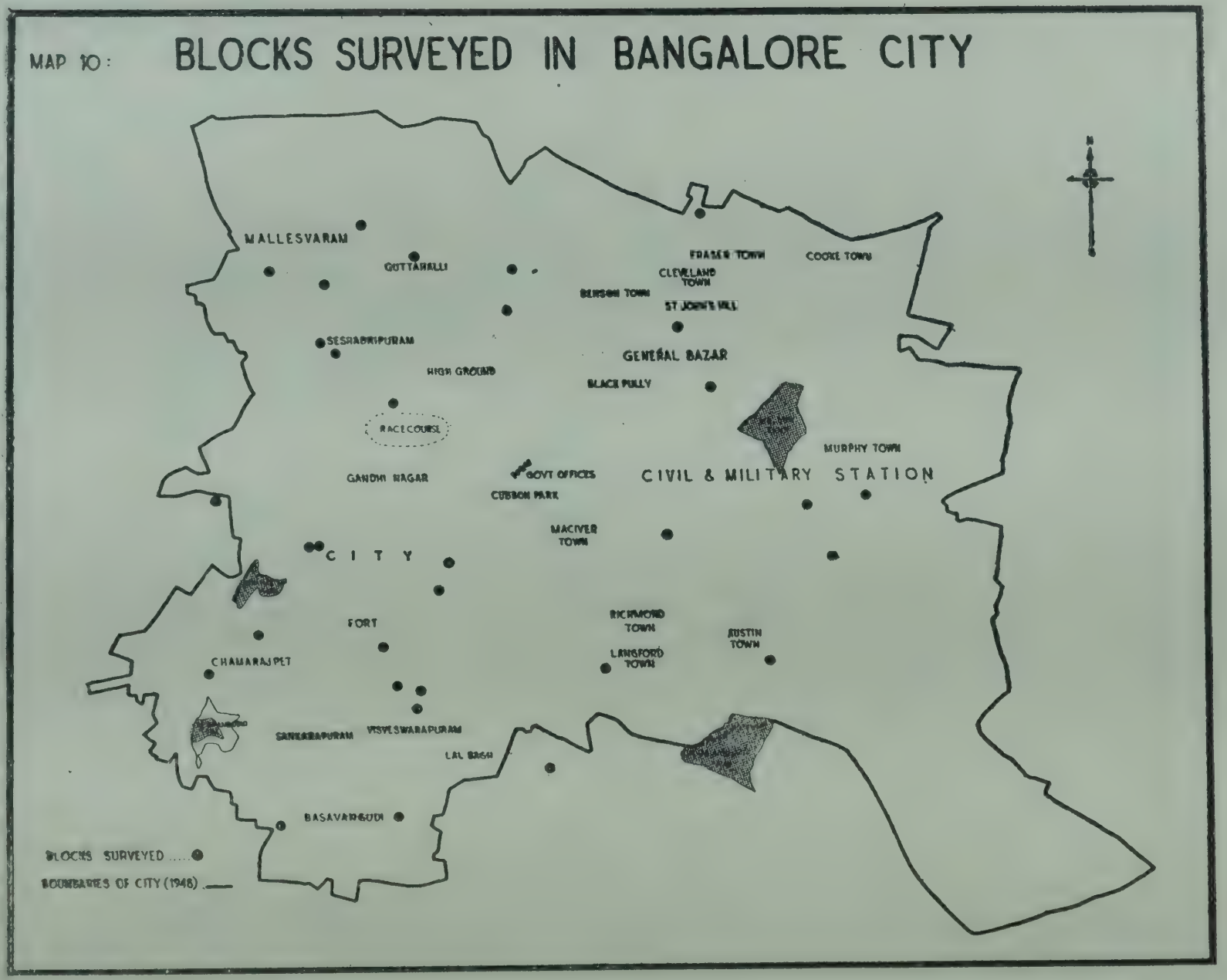

MAP 8: BLOCKS SURVEYED IN DELHI CITY
N
S
CIVIL LINES
DELHI UNIVERSITY
SABZI MANDI
KASHMIRI GATE
JUMNA RIVER
D E L H I
RED FORT
KAROL BAGH
PATEL NAGAR
DARYAGANJ
WEST DELHI
GOLE MARKET
CONNAUGHT PLACE
RASHTRAPATI BHAWAN
INDIA GATE
N E W D E L H I
DIPLOMATIC ENCLAVE
CANTONMENT
LODI COLONY
VINAY NAGAR
SOUTH DELHI
KALKA JI
BLOCKS SURVEYED.....
APPROXIMATE BOUNDARY.....

MAP 9:

BLOCKS SURVEYED IN HYDERABAD CITY

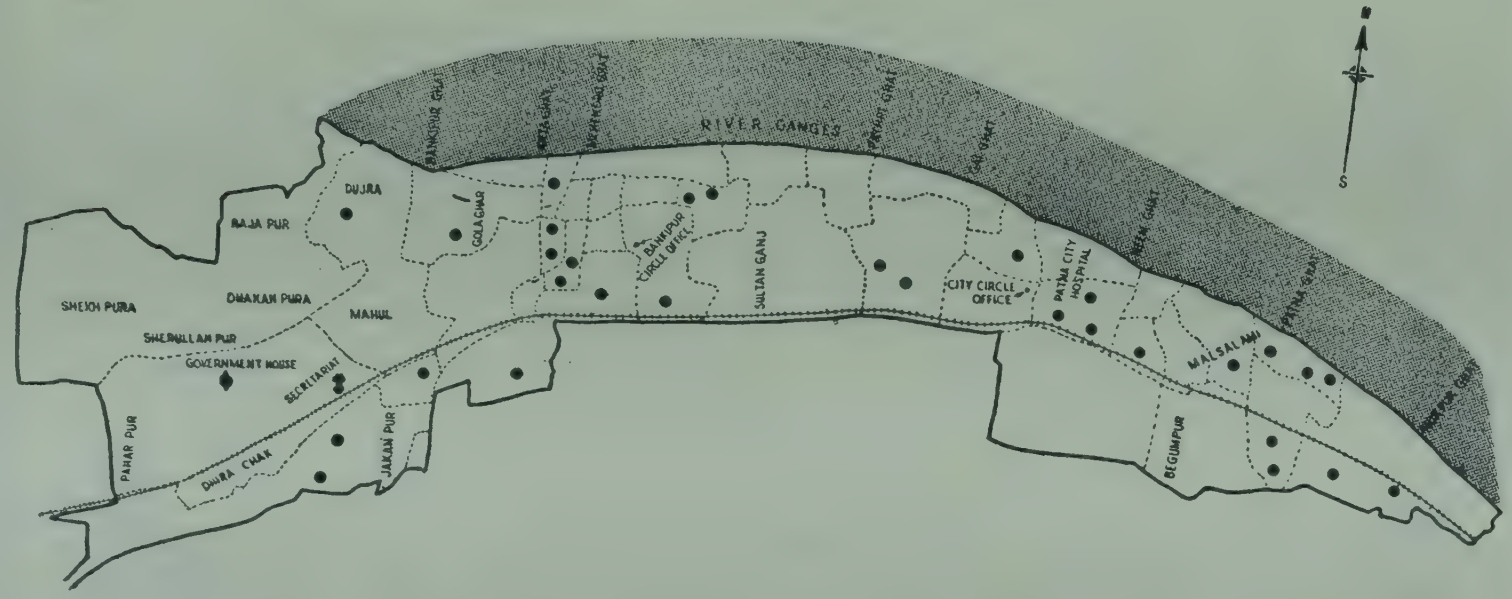


MAP 10: BLOCKS SURVEYED IN BANGALORE CITY



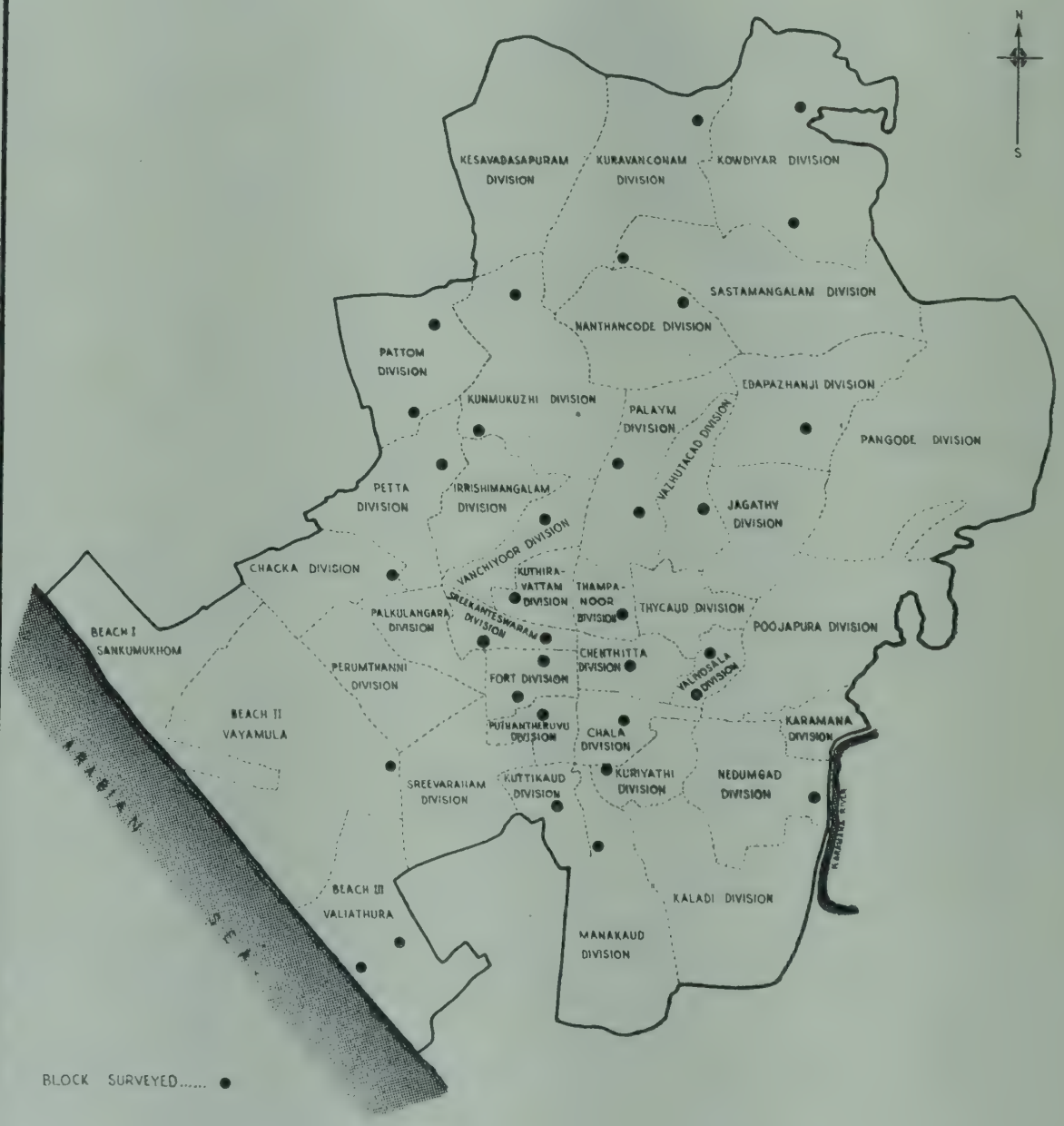
MAP 11.

BLOCKS SURVEYED IN PATNA CITY



MAP 12

BLOCKS SURVEYED IN TRIVANDRUM CITY



CHAPTER IV

READING OF X-RAY FILMS AND ESTIMATION OF THE NUMBER OF TUBERCULOSIS CASES

(a) Variation between local readers

The design of the survey called for independent readings of the films in each zone by two local readers. Each of them had classified the films into normals and abnormals, the latter group including not only definite or doubtful cases of tuberculous pathology but also those with evidence of non-tuberculous conditions and even mere calcification. The percentages of films classified as abnormal by the local readers in each zone are presented in Table 4·1. Wide variations were found in the percentage of films marked 'abnormal' by the two local readers. In addition it will be seen from Table 4·2 that there were considerable variations between the local readers in marking out the radiologically positives *i.e.*, those classified as 'C' or 'D' under aetiology code on page 13 (Chapter II). Such variations in the reading of *x*-ray films have been recorded in many other studies (Yerushalmy 1947, Groth-Peterson *et al.* 1952, Newell *et al.* 1954, Holm *et al.* 1954). These variations not only complicate the estimation of the morbidity rate for any one zone, but create difficulties in making inter-zonal comparisons of disease prevalence. An attempt was made to overcome these difficulties by using 'central readers'.

Table 4·1

Variations in the percentage of films classified as 'abnormal' by the local readers in the different zones

	Zones					
	Calcutta	Delhi	Hydera-bad	Madana-palle	Patna	Trivan-drum
Total number of films read	26,614	59,070	62,860	48,563	38,670	63,060
Number classified as abnormal by :						
(a) 1st local reader	913	5,966	9,648	3,419	3,553	2,472
(b) 2nd local reader	1,104	4,747	9,322	1,542	1,458	5,793
(c) One or both of the local readers	1,367	6,748	10,693	3,881	3,941	6,074
Percentage of abnormals by :						
(a) 1st local reader	3·4	10·1	15·3	7·0	9·2	3·9
(b) 2nd local reader	4·1	8·0	14·8	3·2	3·8	9·2
(c) One or both of the local readers	5·1	11·4	17·0	8·0	10·2	9·6

TABLE 4·2

Variations in the percentage of films classified as 'Radiologically Positive' ('C' or 'D') by the local readers in the different zones.

	Zones					
	Calcutta	Delhi	Hydera-bad	Madana-palle	Patna	Trivan-drum
Total number of films read	26,614	59,070	62,860	48,563	38,670	63,060
Number classified as 'C' or 'D' by :						
(a) 1st local reader	332	988	5,406	863	403	814
(b) 2nd local reader	406	1,013	5,814	441	229	985
(c) One or both of the local readers	526	1,301	6,128	989	434	1,059
Percentage of 'C' or 'D' by :						
(a) 1st local reader	1·2	1·7	8·6	1·8	1·0	1·3
(b) 2nd local reader	1·5	1·7	9·2	0·9	0·6	1·6
(c) One or both of the local readers	2·0	2·2	9·7	2·0	1·1	1·7

(*b*) USE OF CENTRAL READERS

(*i*) *Procedure suggested by some workers in other countries.*—Yerushalmy (1956) has discussed the advantage of using multiple readings for radiological diagnosis. If, for instance, a second independent reading of each film was taken, the group of films classified as radiologically positive by at least one of the two readers will include a much larger proportion of 'true positives' than the group of films classified as radiologically positive by any one reader. At the same time the former group will include a larger number of 'false positives' than the latter. The use of multiple readers, therefore, provides a method of obtaining a group which contains a high proportion of the 'true positives', but to be of real value it is necessary to devise a procedure by which most of the 'false positives' in this group could be rejected. For this purpose it has been suggested that all the films in this group which were interpreted as positive by one reader and negative by the other should be submitted to a third interpretation and that this third reading should be done with the knowledge that the first two diagnoses were in disagreement (Yerushalmy 1956).

(*ii*) *Need for investigations to evolve procedures to suit the present survey.*—In this survey, the films from each zone had been read by two local readers. Although

these readers had read the films independently, they were usually persons working closely at the same centre. Some similarity in the manner in which they read films was therefore to be expected. Whether in these circumstances a third reading by the central reader of only these films on which there was disagreement between the local readers would yield satisfactory results required consideration. It was also realised that the alternative of submitting all the films for a third reading by the central readers would prove impracticable because of the heavy work involved. Special investigations were therefore undertaken with a view to evolve a satisfactory procedure in regard to third reading by the central readers and using these in the final radiological diagnosis.

(*iii*) *First Investigation*: *Independent reading by central readers.*—The submission of all films to the central readers could with advantage be avoided if by using the readings of the local readers a smaller group could be selected for reference which would contain most of the 'true positives'. It was thought that by taking all the films marked 'abnormal' by one or other of the local readers, an effective screening of the 'true positives' could be made. To investigate this point about 2,000 films in rolls selected randomly from each zone were given to each of three central readers for independent interpretation. It will be seen from the data presented in Table 4·3 that 109 out of 33,985 (i.e. 3·2 per 1000) films marked normal by both the local readers were classified by the central readers as 'C' or 'D', which as stated earlier formed the major component in the estimation of the morbidity rate. Not all the films thus classified were likely to be 'true positives' as the central readers might have wrongly classified some of the films as 'positive'. In the absence of follow-up or more detailed investigations it was not possible to say precisely as to what proportion of them was truly positive.

Some idea can be obtained from the following considerations. In the group of 35,911 films submitted to the central readers 33,985 had been marked as 'normal' by both local readers and the remaining 1,926 as 'abnormal' by one or both of them. In accordance with the design of the survey bacteriological examinations had been made in these 1,926 cases. These bacteriological findings provide some basis for the assessment required.

In the 1,926 cases there were 159 which had been classified as other than 'C' or 'D' by both local readers but as 'C' or 'D' by the central reader. Of these 159, only 4 were bacteriologically positive. The number of true positives among 159 can be reasonably assumed to be ten times* the number established as bacteriologically positive i.e. 40. The 'true positives' work out to 25 per cent in this group of films classified as 'C' or 'D' by the central reader.

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* The ratio of one in ten assumed for asymptomatic cases of tuberculosis established as positive in one bacteriological examination appeared justified both in the light of data obtained in the present survey as well as of experience of tuberculosis workers in India.

The 'true positives' in the 109 cases marked 'C' or 'D' by the central reader but as 'normal' by both the local readers should normally be expected to be less than the 25 per cent noted for the above group of 159 cases i.e. 27 at the most.

TABLE 4·3

Percentage of films classified as 'C' or 'D' by central readers among normals as given by both local readers.

(from sample used in the first investigation)

	Zones						
	Calcutta	Delhi	Hydera-bad	Madana-palle	Patna	Trivan-drum	Total
Number of films in sample.	5567	6146	4913	6021	6530	6734	35,911
Number marked normal by both local readers.	5282	5699	4626	5707	6233	6438	33,985
Number marked 'C' or 'D' by central readers in films marked normal by both local readers.	19	12	21	7	17	33	109
Number marked C' or 'D' by central readers per 1000 films marked normal by both local readers.	3·6	2·0	4·6	1·3	2·7	5·1	3·2

Assuming a true morbidity rate of 2 per cent in the community. 718 cases of tuberculosis may be expected in the 35,911 films referred to the central readers. If instead of submitting all the films only those classified as 'abnormal' by at least one of the local readers had been submitted for central reading, only 27 out of the 718 cases (or 3·8 per cent) would have been lost. It may therefore be concluded that a satisfactory screening of 'true positives' could be effected by selecting films which were classified 'abnormal' by one or both the local readers, inasmuch as they were likely to include 96 per cent of the 'true positives'.

(iv) Second Investigation : Dependent readings by central readers of films classified as abnormal by one or both local readers.—In the group of films 'screened' as suggested above, the main problem would be to pick out those which are truly positive. How far this could be done by one reading of these films by a central reader with full knowledge of the readings by the local readers was investigated. Six central readers were each given about 2,000 films in rolls drawn randomly from

each of six zones, along with the detailed readings of each film classified as abnormal by at least one of the local readers. They were asked to read all these 'abnormals' and mark them according to their own judgement after taking into account the entries made by the local readers. In discussing the results of this investigation, films classified as 'C' or 'D' under aetiology would be called radiologically positive and the remaining films (classified as other than 'C' or 'D') 'radiologically negative'.

The percentage of films which each central reader rejected as radiologically negative out of those marked as radiologically positive by one or both of the local readers are shown in Table 4·4. On an average the central readers rejected 32 to 49 per cent of such films It would further be seen from the data in Table 4·5 that the percentages of rejections were much higher in cases which were marked 'C' or 'D' by one of the local readers only as compared to that in cases marked as 'C' or 'D' by both of them. Inasmuch as the central readers had all the details for such films recorded by the local reader, it may be presumed, *prima facie*, that most of such rejections were of the 'false positives' of the local readers.

TABLE 4·4

Percentage 'rejected' by each central reader out of the films classified as 'C' or 'D' by one or both of the local readers, by zones.*

(from sample used in the second investigation)

Central readers	Zones						All zones
	alcut	Delhi	Hyderabad	Madana-palle	Patna	Trivandrum	
R_1	60·6	42·1	86·1	48·0	15·4	39·5	48·6
R_2	18·9	35·9	75·6	35·0	2·9	32·4	33·4
R_3	43·4	33·3	82·0	30·8	34·6	45·2	44·9
R_4	39·5	41·7	64·4	10·3	13·3	22·0	31·9
R_5	53·6	30·0	75·2	56·1	23·8	32·7	45·2
R_6	42·3	22·0	75·5	25·0	26·1	40·8	38·6
All readers	43·0	34·2	76·5	34·2	19·4	35·4	40·4

* The term 'rejected by central readers denotes that whereas one or both of the local readers marked a film as 'C' or 'D' the central reader marked it otherwise.

TABLE 4·5

Percentages 'rejected' by central readers out of two groups of films—(a) classified as "C" or 'D' by both local readers and (b) classified as 'C' or 'D' by one local reader only.*

(from sample used in the second investigation)

	Zones						
	Calcutta	Delhi	Hydera-bad	Madana-palle	Patna	Trivan-drum	All zones
(a) Films classified as 'C' or 'D' by both local readers	104	137	512	48	60	145	
Number 'rejected' by central readers.	14	16	386	5	1	31	
Percentage 'rejected'	13·5	11·7	75·4	10·4	1·7	21·4	22·2
(b) Films classified as 'C' or 'D' by only one local reader	166	127	61	116	73	78	
Number 'rejected' by central readers.	92	74	50	60	24	46	
Percentage 'rejected'	55·4	58·3	82·0	51·7	32·9	59·0	57·1

* The term 'rejected' by central readers denotes that whereas one or both of the local readers marked a film as 'C' or 'D' the central reader marked it otherwise.

This point could be investigated further as films marked abnormal by the local readers had been submitted to bacteriological examination and it was possible to correlate the film readings of the local and central readers with the bacteriological findings. Relevant data for all zones combined are given in Table 4·6. These show, as may be expected, that the percentage bacteriologically positive was highest in films marked 'C' or 'D' by both the local readers as well as the central

TABLE 4·6.

Percentage bacteriologically positive among groups of films, classified as 'C' or 'D', according to type and number of readers doing so.
(from sample used in the second investigation)

Group of films classified as 'C' or 'D'	Number of films in the group	Number bacteriologically positive in Col. (2)	Percentage bacteriologically positive
(1)	(2)	(3)	(4)
I. By both the local readers and central reader.	553	133	24·1
II. By one of the local readers and central reader.	267	24	9·0
III. By central reader only.	276	15	5·4
IV. By both the local readers but not by the central reader.	453	7	1·5
V. By one local reader but not by central reader.	348	12	3·4
Total	1897	191	10·1

reader (Group I) and was 24·1. The next highest percentage *viz.* 9·0, was found in Group II marked 'C' or 'D' by one of the local readers only and confirmed to be so by the central reader. In comparison, films marked 'C' or 'D' by both the local readers but not by the central reader (Group IV) gave a low percentage for bacteriologically positives *viz.*, 1·5. As in both the latter groups, films were accepted by two readers out of the three (two local and one central) the difference in the percentages shows that acceptance was more dependable, if one of the two readers doing so was the central reader. Similarly, films classified by the central reader as 'C' or 'D' but not so by both the local readers (Group III) showed a higher percentage of bacteriologically positives, 5·4, than films classified as 'C' or 'D' by one of the local readers but not so by the central reader (Group V). Therefore, among films accepted by only one reader, greater reliance could be placed on those accepted by the central reader. Similarly, by comparing the percentage of films which proved bacteriologically positive in Groups II and V as well as in Groups I and IV, it appeared that films rejected by the central reader contained a much smaller proportion of 'true positives' than films accepted by him. As such, acceptance as well as rejection of films as 'C' or 'D' by the central reader with full knowledge of the classifications made by the two local readers appeared

to have definite usefulness in arriving at a correct estimate of disease prevalence.

(*v*) *Procedure finally adopted.*—The method by which the readings of the central reader could be used to finally classify the films as showing evidence of morbidity or not (*i.e.* whether or not they are 'C' or 'D'), among those judged abnormal by one or both of the local readers, had to be considered. Three procedures appeared possible :—

I. to accept all films which were classified as 'C' or 'D' by any two of the three readers *viz.* the two local and one central reader ;

II. to accept all films which were classified as 'C' or 'D' by the central reader, irrespective of the readings of the local readers ; and

III. to accept all films which were classified as 'C' or 'D' by both the local readers as well as all other films which were classified as 'C' or 'D' by the central reader.

The relative merits of these three procedures were assessed by making use of the data in Table 4·6, and the following assumptions :—

(1) The films classified as 'C' or 'D' by both the local readers as well as the central reader are all 'true positives', and

(2) The number of 'true positives' in the other four groups *viz.* Groups II to V in Table 4·6 would be ten times* the number which were established as bacteriologically positive in these groups.

The numbers of 'true positives' in the five groups as determined by these two assumptions are given in Table 4·7. This table also shows the numbers which would be classified as positive if the three procedures suggested above were used and how many of them would be 'true positives' and how many 'false positives'. Considering the total number of films which would be classified as positive, it is seen that the second procedure gives a number (*viz.* 1,096) which is closest to the true value (*viz.* 1,133) while the first and third procedures give respectively 1,273 and 1,549. The second procedure is therefore likely to lead to the estimation of morbidity rates which are closest to the actual and was preferred for our work. It may, however, be pointed out that of the three procedures, the third one will lead to the inclusion of the largest proportion of the 'true positives' (1,013 out of 1,133) as compared with the other two. This advantage of the third procedure over the second is, however, lost because of the inclusion of a larger number of 'false positives' by this procedure.

(*c*) Radiological diagnosis using third reading and its accuracy

The procedure finally decided upon in regard to radiological diagnosis was as follows :—

(1) Films classified as 'normal' by both the local readers would be accepted as such without reference to the central reader ; and

*See footnote on page 33.

TABLE 4·7.

Number of 'True Positives' expected and the numbers which will be classified as positives by the three procedures for the third reading

(from sample films used in the second investigation)

Group of films classified as 'C' or 'D'	Total number of films	Number of true positives expected	Procedure I			Procedure II			Procedure III		
			Number of true positives	Number of false positives	Number of positives (both true and false)	Number of true positives	Number of false positives	Number of positives (both true and false)	Number of true positives	Number of false positives	Number of positives (both true and false)
1. By both the local readers and central reader	553	553	553	—	553	553	—	553	53	—	553
2. By one of the local readers and central reader	267	240	240	27	267	240	27	267	240	27	267
3. By central reader only	276	150	—	—	—	150	126	276	150	126	276
4. By both local readers but not by the central reader.	453	70	70	383	453	—	—	—	70	383	453
5. By one local reader but not by central reader	348	120	—	—	—	—	—	—	—	—	—
Total	**1897**	**1133**	**863**	**410**	**1273**	**943**	**153**	**1096**	**1013**	**536**	**1549**

(2) In regard to films classified as 'abnormal' by one or both of the local readers, only such of them which were marked 'C' or 'D' by the central reader would be taken as radiologically positive.

The accuracy of diagnosis in using the above procedure can also be estimated from the results of the two investigations given above. By following (1), some of the 'true positives' will be missed. Their proportion has been estimated from the first investigation as 0·8 per 1,000 (27 out of 33,985) of the films read as 'normal' by both readers. Because of (2), some cases of 'true positives' will be missed while some 'false positives' will be included. Out of 7,023 films read as 'abnormal' by one or both readers, in the sample selected for the second investigation, it was estimated that by step (2), 943 'true positives' and 153 'false positives' were likely to be included as radiologically positive while 190 'true positives' were likely to be considered as negative. Hence instead of 1,133 which were assumed as radiologically positive only 1,096 were likely to be regarded as such, leading to an under-estimation of 37 positives.

The above figures can be used to give an estimate of the overall error in radiological diagnosis. The 71,692 films in second investigation contained 64,669 which had been regarded as normal by both the local readers and 7,023 which, as referred to above, were regarded as abnormal by one or both of them. By the central reader not being asked to read the normals roughly $64669 \times \frac{0{\cdot}8}{1000}$ or 52 positives will be missed. From the 'abnormal' films, as stated above, the central reader would miss 37 out of the 1,133 expected. As such out of the total number of 1,133 plus 52 *i.e.*, 1,185 films which were likely to be positive, the procedure for radiological diagnosis suggested above would miss 52 plus 37 *i.e.* 89. The procedure would thus lead to an underestimation of the radiologically positives by $\frac{89}{1185} \times 100$ $=7{\cdot}5$ per cent.

In the above estimation of error, no account has been taken of the fact that the results of the bacteriological examination of the 'abnormals' were available and could be used to reduce the loss of 'true positives'. The 190 'true positives' which were estimated to have been missed by following step (2) of the procedure included 19 which were established as bacteriologically positive (See Table 4·6). Taking this number into account the underestimation of radiologically positive cases is reduced to $\frac{(89-19)}{1185} \times 100 = 5{\cdot}9$ per cent.

(*d*) Reducing the work load of central readers

Having decided on the procedure stated above for radiological diagnosis by the use of the third reading, the straight-forward procedure would be to submit all the abnormals for a third reading by central readers. In doing so, the division of the abnormals from each zone equally between the different central readers would have

made zonal comparisons easier by averaging the personal bias in reading of the central readers. As in the course of the second investigation discussed earlier six central readers had together read on an average about 25 per cent of the abnormal films from each zone the question whether additional abnormal films had to be given for third reading had first to be considered. Statistical scrutiny showed that with the exception of the Hyderabad zone the number of abnormal films read by the central readers in connection with the second investigation was adequate enough to provide a sound basis for estimating the number of radiologically positives (*i.e.* 'C' or 'D') that could be expected in each zone, without the central readers having to read all the abnormals from that zone. In this particular zone, a further sample was found necessary as the method of radiological reading by the local readers had undergone a marked change during the course of the Survey, and the original sample was not large enough to provide a proper basis for estimating the 'C' or 'D' cases prior to and after this change. This decision of not having further readings of films except in the Hyderabad zone, besides reducing the cost made it possible to take up the work of processing the data without delay. However, as the number of cases which would have been classified as 'C' or 'D' by the central readers had now to be estimated using correction factors derived from the sample used in the second investigation, it made the statistical task somewhat more complicated. The statistical procedure used for the estimation is discussed in the next section.

(*e*) Estimation of the number of tuberculosis cases

The general principle used in estimating the number of radiologically positive cases (*i.e.* 'C' and 'D' under aetiology) to be expected if all the abnormals had been given a third reading by a central reader was as follows :

If 'N' be the total number of abnormals,

'*n*' the number of abnormals read by the central readers in the sample selected for second investigation,

'*t*' the number of cases marked 'C' or 'D' by the central readers in the '*n*' films read by them, and

'T' the number of cases of 'C' or 'D' expected in the 'N' films if all of them were read by the central readers,

then $T = \frac{N}{n} \times t.$

In order to increase the accuracy of estimation, a number of groups was made of the abnormals and the number of cases of 'C' or 'D' to be expected in each group was first estimated. The total number expected in all the groups was obtained by adding the estimate for each of the groups composing it. The groupings were made taking into account the classification of aetiology by the local readers, as well as the results of bacteriological examination. The two classes according to aetiology were :-

(1) 'C' or 'D' by one or both local readers, and

(2) abnormals other than 'C' or 'D' by both local readers.

The four classes according to bacteriological examination were :—

(1) Selected for bacteriology and found positive ;

(2) Selected for bacteriology and found negative ;

(3) Selected for bacteriology but bacteriology not done ; and

(4) Not selected for bacteriology.

Of the eight groups obtained by cross-tabulating the two aetiology classes with the four according to bacteriological examination, only seven were possible as all the films marked 'C' or 'D' by the local readers were to be selected for bacteriological examination. Among the seven groups possible, the formula given on page 41 was applied to five; in the two groups relating to 'selected for bacteriology and found positive', the principle adopted was to take all cases as tuberculous. The scheme used for the estimation of the total number of tuberculosis cases is shown on page 43.

(*f*) Adjustment for hospitalised cases

The sample survey was designed to obtain prevalence rates for the population on a 'resident' basis. As such, 'residents' who were in tuberculosis hospitals or sanatoria had to to be separately considered. During the listing of population in each village or block, information regarding such persons was recorded in the Household Schedule. However, as their numbers were negligible it was not felt necessary to make any correction on this account to the estimates obtained from the method described in (*e*) above. It may further be added that the number of beds available in the country for tuberculous patients being comparatively few the number which would be missed by being admitted to a hospital would be extremely small.

Scheme for the estimation of the number of tuberculous cases

Group	Number in each group		Number marked as 'C' or 'D' by central readers in each group from the sample	Number of estimated tuberculous cases in each group
	From all abnormals	From abnormals in the sample		
1. Films marked 'C' or 'D' by one or both local readers :				
(i) Bacteriologically positives	N_1	n_1	t_1	T_1*
(ii) Bacteriologically negatives	N_2	n_2	t_2	$T_2 = \frac{N_2}{n_2} \times t_2$
(iii) Bacteriology not done, though selected for it	N_3	n_3	t_3	$T_3 = \frac{N_3}{n_3} \times t_3$
(iv) Not selected for bacteriology	—	—	—	—
2. Films marked as abnormals other than 'C' or 'D' by one or both local readers :				
(i) Bacteriologically positives	N_4	n_4	t_4	T_4*
(ii) Bacteriologically negative	N_5	n_5	t_5	$T_5 = \frac{N_5}{n_5} \times t_5$
(iii) Bacteriology not done, though selected for it	N_6	n_6	t_6	$T_6 = \frac{N_6}{n_6} \times t_6$
(iv) Not selected for bacteriology	N_7	n_7	t_7	$T_7 = \frac{N_7}{n_7} \times t_7$

*Actual number established as bacteriologically positive and not estimated.

CHAPTER V

ESTIMATION OF THE NUMBER OF BACTERIOLOGICALLY POSITIVE CASES

(*a*) Procedure for bacteriological examination

The plan of the survey called for the bacteriological examination of all persons whose *x*-ray pictures were considered to be abnormal by one or both of the local readers, the only exception being that films showing mere calcifications were not to be considered abnormal for this purpose. For all such persons specimens were to be collected for the following examinations :—

(1) Sputum for direct smear (2 slides) ;
(2) Sputum for culture (2 tubes) ;
(3) Laryngeal swab for culture (2 tubes).

Smears from sputum were made in the field and stained. The slides were examined in the field by the bacteriologist or laboratory technician and again by another independent observer at the headquarters laboratory. Cultures were made in the improvised field laboratory using the oxalic acid sodium citrate neutralisation technique. Laryngeal swabs were also taken and any further material brought out at the time of taking swabs was also included for examination. The material collected was packed in ice-boxes and transported to headquarters as early as possible to avoid deterioration. Incubation of cultures and further examinations were done at headquarters. If tubercle bacilli were found during any one of the three examinations, the person was considered to be bacteriologically positive and relevant entries were made in his *x*-ray card.

Some centres, in the earlier part of the survey, noticed a high contamination rate. It was suspected that solutions used in the tests, being stored and re-used under field conditions, were getting contaminated. This procedure was then altered by supplying sterile solutions in appropriate amounts in individual McCartney bottles—a set of bottles for each sample. This alteration brought down the contamination rate within normal limits.

(*b*) Variation in procedure between zones

The procedure described above has been generally followed by all centres, but the details of the culture technique as well as the media used differed somewhat from zone to zone. Two experienced bacteriologists were, therefore, deputed to appraise the actual procedures in different zones and to assess how far differences in these were likely to affect the final results. The data collected by them are

summarised as follows :—

(*i*) *Collection of specimens.*—(*a*) Laryngeal swabs were generally collected using the 'blind' technique, the only exception being Calcutta which followed the original technique of using head-lamps, laryngeal mirror and tongue depressor.

(*b*) Sputum was collected at the time of visit in some centres, over-night sputum was used by some others and in one centre (Delhi) a mixture of both, in one bottle, was used.

(*c*) In Trivandrum zone all the types of specimens required were not collected for a number of persons.

(*ii*) *Smears.*—Smears were made by swabs, platinum loops, sticks either split or not split at the ends. In some laboratories an attempt was made to select specific parts of the sputum for smear, whereas in others no such special attention was paid.

Staining differed only in the counterstain used, the variations being, no counterstain at all, picric acid, Loeffler methylene blue, 0·5 per cent methylene blue and 1 per cent of methylene blue.

(*iii*) *Medium.*—All centres except Trivandrum used Lowenstein-Jensen medium, modified with regard to the use of potato starch, either no potato being used as recommended by the International Union Against Tuberculosis (I.U.T.M.) or with raw potato extract. Trivandrum used Medlar-Sassano medium. With the exception of Trivandrum, the medium seemed satisfactory and generally gave good growth.

(*iv*) *Technique of culture.*—(*a*) *Laryngeal swabs.* All the laboratories used the oxalic acid sodium citrate method, the only difference being that some sterilised the solutions in small quantities in the tubes or bottles to be used for the swabs, whereas others did it in somewhat larger quantities which were poured into tubes at the time of processing the swabs.

(*b*) *Sputum swabs.*—All the laboratories used the technique as described above under "laryngeal swabs". One of the centres used only one swab for culture whereas all the others used two.

(*v*) *Additional examinations.*—All centres except Hyderabad carried out certain additional examinations. Delhi and Madanapalle centres used an additional sputum swab in the laboratory. Additional sputum examination after homogenising was done in Calcutta, Madanapalle, Patna and Trivandrum centres. Calcutta using several methods of homogenising, Madanapalle homogenising with 5 per cent H_2SO_4, Patna with 6 per cent H_2SO_4 and Trivandrum with 4 per cent NaOH.

(*vi*) *Reading of cultures.*—Test readings of cultures showed that those given by the laboratory workers were in agreement with those of the two bacteriologists who visited the different centres.

(c) Effect of variations in procedure between zones on the proportion of bacteriologically positives

After careful consideration of the differences stated above, these bacteriologists came to the conclusion, that except for the Trivandrum zone, the procedures used at the different centres for the collection of specimens and processing were fairly comparable. They, however, observed that the use of a strong counter-stain might cause the loss of a few positives and lead to an underestimation of the bacteriologically positives, while additional methods employed in some laboratories might have increased the percentage of positive findings by as much as 7 per cent.

The singling out of the Trivandrum zone by the bacteriologists was also corroborated by an analysis of the data from the second investigation described in chapter IV. Relevant details of the percentage bacteriologically positive, among those classified as "C" or "D" by the central readers, are shown in Table 5·1. Whereas in other zones nearly 17 per cent of the cases classified as 'C' or 'D' by central readers were found positive by bacteriological examination, the corresponding figure for Trivandrum zone was only 8 per cent.

Table 5·1

Percentage of bacteriologically positives among those classified as 'C' or 'D' by central readers in the different zones.
(from sample used in the second investigation)

	Calcutta	Delhi	Zones		Patna	Trivandrum	Total
			Hyderabad	Madanapalle			
Films marked 'C' or 'D' by the central readers.	175	196	185	157	203	209	1125
Bacteriologically positives among 'C' or 'D' by the central readers.	33	34	34	21	36	17	175
Percentage bacteriologically positive among those marked as 'C' or 'D' by central readers.	18·9	17·3	18·4	13·4	17·7	8·1	15·6

Apart from what has been stated above there were other factors which were likely to affect the comparability of the results in different zones. In Madanapalle zone, the persons to be bacteriologically examined were selected on the basis of the results of a single local reader only, and this might have resulted in a slight underestimation of the number bacteriologically positive in that zone. This was corroborated by the smaller percentage of bacteriologically positives in this zone observed in Table 5·1. In the Calcutta zone, laboratory facilities were not available for a long time with the result that in the earlier stages, bacteriological examinations were considerably delayed. How far this would have affected the final results in that zone is not clear.

Even within a zone, conditions of work, from the laboratory point of view, differed from place to place. For instance, these were not as good in the towns as in the cities and were even less satisfactory in the villages. Such differences would well have affected the positivity rate in the different areas within each zone.

(*d*) Estimation of bacteriologically positives

Although all the cases classified as abnormals (excepting the ones showing mere calcification) had to be bacteriologically examined, for various reasons it was not possible to carry out the examination of all these cases. The number of bacteriologically positives which could be expected among those who could not be examined had, therefore, to be estimated. The general principle used was that if

N_1 is the number who were bacteriologically examined,

N_2 the number who could not be bacteriologically examined, and

n_1 the number found bacteriologically positive among the N_1, then

n_2 the expected number of bacteriologically positives among the N_2 is given by :

$$n_2 = \frac{n_1}{N_1} \times N_2.$$

In applying the principle, the cases to be examined bacteriologically were divided into two groups (1) those which were marked 'C' or 'D' by one or both of the local readers and (2) other abnormals which were not marked 'C' or 'D' by both the local readers. The numbers to be expected among those that could not be bacteriologically examined in these two groups were separately estimated by applying the formula given above. The two numbers so estimated were added to the numbers that were established as bacteriologically positive among those examined in these groups to provide the total number of bacteriologically positive cases.

The scheme used is presented in the following table.

Scheme for estimation of bacteriologically positive cases

	Films classified as	
	'C' or 'D' by one or both local readers.	Other than 'C' or 'D' by both local readers
Number bacteriologically examined.	N_{11}	N_{12}
Number bacteriologically not examined.	N_{21}	N_{22}
Number found bacteriologically positive among those examined.	n_{11}	n_{12}
Expected number of bacteriologically positive among those not examined	$n_{21} = \frac{n_{11}}{N_{11}} \times N_{21}$	$n_{22} = \frac{n_{12}}{N_{12}} \times N_{22}$

CHAPTER VI

FINDINGS OF THE SURVEY

In the preceding two chapters the types of data available from the survey and the methods of utilising them to work out the number of (1) radiologically positive cases and (2) bacteriologically positive cases in the villages or census blocks selected for survey were discussed. Although the survey was centrally planned in as much as it had extended to six zones spread over the country, certain variations in the data due to difference between the zones in conditions of work and personal factors were inevitable. Special attention was, therefore, given to arriving at data valid for inter-zonal comparisons. In the present chapter the manner in which the data so obtained for the individual village or census block could be used to obtain estimates of the prevalence rates for the city, towns and villages, in each zone will be discussed. The findings and conclusions of the survey in regard to the prevalence rates will also be presented.

(*a*) Indices used for assessing prevalence of morbidity

Two indices have been used for assessing prevalence of morbidity. These are :—

(1) *Number of 'active' and 'probably active' cases per 1000 population.* This index will give per 1000 persons the number of bacteriologically positive cases plus the radiologically positives (*i.e.* classified as 'C' or 'D' under Aetiology) among those in whom bacilli was not demonstrated.

(2) *Number of bacillary cases per 1000 population.*—This index will give per 1000 persons the number of bacteriologically positive cases.

Whereas the second index will include all cases who should be treated and isolated, the first index may include some who may need only observation.

Using the procedures discussed in Chapters IV and V data given by the survey were first used to obtain (1) the number of 'active' and 'probably active' cases and (2) the number of bacillary cases in each village or census block surveyed. The populations *x*-rayed in each of these units were directly available from the survey. These data of the units were then utilised to obtain estimates of the prevalence rates in the city, towns and villages in each zone. The formulae used for estimating these rates as well as their standard errors are given in Appendix 2.

(*b*) Limitations of the data

These rates as obtained from the survey data suffer from certain limitations. As already explained in Chapter IV, the number of radiologically positive cases is

likely to be slightly underestimated by applying the procedures described in it. The first index *viz.*, the number of 'active' and 'probably active' cases per 1000 population, which is calculated from such estimates, is, for this reason, likely to be underestimated to the same extent. The bacillary rate is likely to be underestimated to a much larger degree for a variety of reasons, one of the most important being that bacteriological examinations were confined to specimens collected during one visit only. Moreover, the extent of underestimation is likely to vary from zone to zone due to the variations in procedure discussed in Chapter V and this introduces difficulties in making inter-zonal comparisons of the second index *viz.*, the number of bacillary cases per 1000 population.

The inability to *x*-ray all the eligible persons in the sample also introduces certain difficulties in the working out of the indices as well as in interpreting any differences in them, especially because in a survey of this nature, persons not presenting themselves for *x*-ray may be selective. At one extreme they may be persons suffering from tuberculosis and therefore unable to present themselves for *x*-ray. On the other, they may be the ones who are very healthy and are away from home on active work. Even if reasons for failure to report for *x*-ray are available, as in the present survey, satisfactory adjustments become difficult. It was for this reason that the plan of the survey emphasised the *x*-raying of close to 100 per cent of the eligible population. If the non-*x*-rayed form only a small fraction of the eligibles, the indices as worked out from the data of the *x*-rayed can be considered satisfactory. In view of its importance, data on the percentage of eligibles who were actually *x*-rayed is considered below.

Extent of coverage of the eligible population.—The indices of morbidity could be considered to be more reliable in groups where about 90 per cent of the eligible population were *x*-rayed and a fairly high fraction of those showing suspicious *x*-rays were bacteriologically examined. The extent to which such coverage was achieved in different zones is shown in Tables 6·1 and 6·2. It would be observed that response was well upto this limit in most of the areas. The important exceptions for *x*-ray were the towns of Patna zone and all the three cross-sections (city, towns and villages) in Trivandrum zone. In all zones the response was generally better in the villages.

The main reasons on account of which some persons could not be *x*-rayed are given in Table 1, Appendix 3. It would be observed that in most of the zones, a large proportion of those not *x*-rayed were absent from the locality at the time of the survey. In Patna and Trivandrum zones a high proportion of the non-*x*-rayed had refused to come for *x*-ray.

The distribution according to age and sex of the persons who could not be *x*-rayed given in Table 2, Appendix 3, shows that except in certain zones the absentees for *x*-ray were distributed more or less evenly in the different age-sex groups.

In view of the relatively high coverage of the eligible population it was felt reasonable to assume that the indices as worked out from the data of persons actually

TABLE 6·1

Percentage of eligible population x-rayed in different zones

Zone	City			Towns			Villages		
	Eligible for X-ray	No. X-rayed	Percentage X-rayed	Eligible for X-ray	No. X-rayed	Percentage X-rayed	Eligible for X-ray	No. X-rayed	Percentage X-rayed
Calcutta	18,707	16,155	86·3	—	—	—	—	—	—
Delhi	24,706	22,780	92·2	12,007	11,215	93·4	26,468	25,075	94·7
Hyderabad	31,656	29,240	92·4	10,841	10,410	96·0	27,061	25,590	94·6
Madanapalle	17,871	15,986	89·5	14,156	12,955	91·5	21,719	19,622	90·3
Patna	16,670	14,970	89·8	12,242	9,880	80·7	14,368	13,820	96·2
Trivandrum	21,709	16,665	76·8	10,302	7,595	73·7	47,655	38,800	81·4
Total	**131,319**	**115,796**	**88·2**	**59,548**	**52,055**	**87·4**	**137,271**	**122,907**	**89·5**

TABLE 6·2

Percentage bacteriologically examined out of those selected for such examination

Zone	City			Towns			Villages		
	B.E. ordered	B.E. carried out	Percentage	B.E. ordered	B.E. carried out	Percentage	B.E. ordered	B.E. carried out	Percentage
Calcutta.	595	440	73·9	—	—	—	—	—	—
Delhi	1,529	1,401	91·6	476	442	92·9	1,215	1,139	93·7
Hyderabad	1,778	1,664	93·6	1,570	1,221	77·8	4,271	3,058	71·6
Madanapalle	1,162	1,067	91·8	821	706	86·0	876	620	70·8
Patna.	630	453	71·9	381	250	65·8	747	667	89·3
Trivandrum	695	540	77·7	479	403	84·1	760	623	82·0
Total	**6,389**	**5,565**	**87·1**	**3,727**	**3,022**	**81·1**	**7,869**	**6,107**	**77·6**

B.E. = Bacteriological examination.

x-rayed would reflect the rates for all the eligible persons. In as much as the main reason for failure to come for *x*-ray was that the person was away from the locality, it was likely that such an assumption would lead to an over-estimation of the morbidity rates. In most of the zones the degree over-estimation could not be larger than 10 per cent which would be obtained if all those not *x*-rayed were assumed to be free from tuberculosis. In Trivandrum and Patna zones this upper limit of the error may be about 25 per cent.

(*c*) Morbidity indices for different population groups

The morbidity rates among males and females in the three cross-sections in different zones are given in Table 6·3 according to the two indices mentioned above. The rates for 'active' and 'probably active' cases as well as for bacillary cases in the different age groups are given in Tables 6·4 and 6·5 respectively. The prevalence of the disease in population groups living in different types of houses given in Table 6·6 is likely to indicate, in a rough manner, the extent of the disease among different economic groups. Besides these, the extent of disease and cavitation among the 'active' and 'probably active' cases are shown in Table 6·7. These percentages have been worked out on the basis of classifications made under pathology and cavity by the central readers when they read the films selected for the second investigation referred to in Chapter IV.

In interpreting differences in the morbidity rates given in the above tables the extent of sampling error in the estimates has to be taken into account. The coefficients of variation of these estimates of morbidity rates were generally in the range of 4 to 25 per cent. The data for each village and for each block of town or city which were used in calculating the actual coefficients of variation are given in Appendix 4.

(*i*) *Variation in morbidity rates for different cross-sections.*—It would be observed from Table 6·3 and Charts 1 and 2 that the number of 'active' and 'probably active' cases varied from 13 to 25 per 1,000 population whereas the bacillary rate varied from 2 to 8 per 1,000 population in the different cross-sections of the population in different zones. One of the significant features revealed by the figures in this table is the absence of any marked difference with regard to the prevalence of the disease in the three cross-sections *viz.*, city, towns and villages. Contrary to expectations, Calcutta city, the largest in the country, did not show a particularly high prevalence rate. A perusal of the morbidity rates for each block, given in Appendix 4 shows that there are wide variations between the blocks in cities. In Calcutta city, for instance, there were blocks showing a prevalence of over 50 per 1,000 whereas there were some others in which the prevalence was only 3 per 1,000. These wide variations and the presence of pockets with high prevalence indicate that even though the present survey provides reliable over-all prevalence rates there is need to undertake further investigations in order to understand better the epidemiology of the disease in the bigger cities.

TABLE 6·3

Morbidity Indices by sex for each cross-section of population.

Zone	Nature of area	Number X-rayed			Active and probably active cases per 1,000 x-rayed			Bacillary cases per 1,000 x-rayed		
		Male	Female	Total	Male	Female	Total	Male	Female	Total
Calcutta	City (Calcutta)	10,050	6,105	16,155	18·30	14·15	16·73	7·16	5·12	6·39
Delhi	City (Delhi)	12,745	10,035	22,780	24·46	15·61	20·56	4·99	2·88	4·06
	Towns	5,980	5,235	11,215	14·13	12·69	13·47	2·99	1·83	2·45
	Villages	13,460	11,615	25,075	14·84	11·98	13·51	2·99	1·92	2·49
Hyderabad	City (Hyderabad)	14,880	14,360	29,240	17·71	13·09	15·44	5·31	3·03	4·18
	Towns	5,480	4,930	10,410	22·99	17·57	20·42	4·47	2·30	3·44
	Villages	13,065	12,525	25,590	23·33	18·33	20·88	2·93	1·62	2·29
Madanapalle	City (Bangalore)	8,337	7,649	15,986	21·55	17·79	19·75	2·33	2·48	2·40
	Towns	6,722	6,233	12,955	31·43	16·72	24·35	11·69	4·29	8·13
	Villages	10,172	9,450	19,622	21·71	10·67	16·39	8·46	3·57	6·11
Patna	City (Patna)	8,135	6,835	14,970	19·13	21·30	20·12	6·43	6·31	6·38
	Towns	5,565	4,315	9,880	21·84	18·12	20·22	6·22	3·98	5·25
	Villages	7,455	6,365	13,820	18·42	14·43	16·58	7·07	4·43	5·85
Trivandrum	City (Trivandrum)	7,850	8,815	16,665	17·19	15·53	16·31	3·70	2·30	2·96
	Towns	3,820	3,775	7,595	21·89	20·51	21·21	3·69	2·70	3·20
	Villages	19,405	19,395	38,800	16·41	12·86	14·64	3·68	1·49	2·59

With regard to the above findings, it must, however, be pointed out that the villages actually surveyed cannot be considered as a random sample of the entire rural population. As has been described earlier, only such villages which were accessible were included for survey and these would be mainly villages on the road side. The proportion of accessible villages to the total number was as low as 15 per cent in some zones. How far such a selection affects the comparison between the urban and rural rates can only be gauged when the results of the survey in the inaccessible villages are available.

Another fact which has a bearing on the differences in the prevalence rates for cities, towns and villages, is the movement of tuberculous persons from one area to another. It is normal for persons from villages who take work temporarily in towns and cities to return to villages when they become chronically ill. On the other hand the possibility of the sick rural population taking temporary residence in towns or cities to obtain better medical facilities is not unknown.

The above findings about the relative incidence in cities, towns and villages are in line with the results of tuberculin testings in connection with the BCG Vaccination Programme. The infection rates in large towns, small towns and villages as revealed by tuberculin surveys are not appreciably different.

The data given in Tables 6·3 to 6·7 as well as the details provided in Appendix 4 of the 'active' and 'probably active' cases per 1000 *x*-rayed in individual blocks and villages from each zone can be used by the local authorities in devising control measures in their zones. It must, however, be emphasised that while the figures are able to give an overall idea of the conditions prevalent in each zone, they would not necessarily represent conditions prevalent in limited areas within each zone. Specific control measures for such areas would normally call for more detailed information than can be provided by this survey.

(*ii*) *Variations for sex and age groups.*—The morbidity rate for females was in general less than for males (Table 6·3 and Charts 1 and 2). This difference arose essentially because of lower rates among females in the age groups of 35 years and over (Table 6·4). In Delhi city, for instance, the rates for males and females were about the same for those below 35 years ; for females above this age the morbidity rate was less than half of that for males.

The morbidity rates showed a continuous increase with age. The prevalence in the age groups above 35 years was considerably higher than in the age groups between 5 and 34 years in most of the areas, as will be seen from tables 6·4 and 6·5 and Charts 3 and 4.

(*iii*) *Morbidity indices for population groups living in different types of houses.*—Table 6·6 shows that the type of house or the economic factors associated with it are not of much significance in the case of villages. In cities, persons living in pucca houses, who may be assumed to be of better economic conditions, show lower prevalence rate than those living in kutcha houses (Charts 5 and 6).

(*d*) Extent of disease and presence of cavitation

The extent of disease and presence of cavitation among 'active' and 'probably active' cases are shown in Table 6·7. It would be seen from this table that a large proportion (39 to 80 per cent) of the 'active' and 'probably active' cases found during the present survey had moderately advanced disease. Of the remaining cases the majority had far advanced disease, and minimal cases generally constituted only a small percentage (2 to 12) of the total cases. The percentage of 'active' and 'probably active' cases who showed definite cavitation varied from 4 to 33. It is of interest to note that the percentages were generally smaller in the cities as compared to the towns. It would thus appear that in cities the prevalence rates were not only lower than was expected but also that a smaller proportion of the cases found therein had definite cavitations.

(*e*) Summary of findings.

The salient findings of the survey may be summarised as follows :—

1. Prevalence rate for 'active' and 'probably active' tuberculosis varied from 13 to 25 per 1000 population in cities, towns and villages in the different zones.
2. The rate of bacteriologically positive cases for 1000 population in these areas varied from 2 to 8.
3. Prevalence rates in cities, towns and villages were generally of the same order.
4. Prevalence rates were lower for females than for males, specially in age groups above 35 years.
5. In general, the prevalence rate showed a continuous increase with age.
6. In the cities the higher prevalence among persons living in kutcha houses as compared to those in pucca houses indicated the possible effect of economic and sanitary conditions.
7. A large majority of the 'active' and 'probably active' cases had moderately advanced disease.
8. Definite cavitation was observed in 4 to 33 per cent of the 'active' and 'probably active' cases, this percentage being generally smaller in the cities.

Table 6·4

Number of active and probably active cases per 1000 x-rayed by age and sex.

Zone	Nature of area	Sex	Population x-rayed by age groups						No. of active & probably active cases per 1000 x-rayed					
			5-14	15-24	25-34	35-44	45-54	55 & above	5-14	15-24	25-34	35-44	45-54	55 & above
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Calcutta	City	Males	2,295	2,810	2,195	1,285	755	710	7·07	10·69	18·21	23·31	34·06	59·19
		Females	1,855	1,415	1,210	720	455	450	5·16	13·76	20·74	14·77	26·19	21·49
		Both sexes	4,150	4,225	3,405	2,005	1,210	1,160	6·22	11·72	19·11	20·25	31·10	44·57
Delhi	City	Males	3,015	2,885	3,205	1,865	1,010	765	7·53	16·15	23·80	34·83	53·23	62·01
		Females	2,660	2,600	2,290	1,065	745	675	7·74	12·71	21·70	17·62	21·97	26·93
		Both sexes	5,675	5,485	5,495	2,930	1,755	1,440	7·63	14·52	22·92	28·57	39·96	45·56
	Towns	Males	1,960	1,320	985	695	585	435	5·32	4·23	11·71	19·41	19·19	78·30
		Females	1,645	1,080	880	660	460	510	6·85	6·87	16·09	15·23	14·46	32·56
		Both sexes	3,605	2,400	1,865	1,355	1,045	945	6·01	5·37	13·77	17·39	17·03	53·21
	Villages	Males	4,270	2,590	1,970	1,795	1,255	1,580	2·75	3·33	10·98	12·88	35·27	57·19
		Females	3,340	2,595	2,030	1,535	1,120	995	5·00	5·91	10·28	17·41	21·02	36·14
		Both sexes	7,610	5,185	4,000	3,330	2,375	2,575	3·74	4·62	10·63	14·97	28·55	49·06
Hydera-bad	City	Males	5,125	3,205	2,555	1,765	1,200	1,030	15·42	10·95	15·58	17·92	31·07	39·52
		Females	4,625	3,220	2,680	1,655	1,150	1,030	13·60	12·38	12·14	12·03	12·65	17·71
		Both sexes	9,750	6,425	5,235	3,420	2,350	2,060	14·55	11·67	13·82	15·07	22·06	28·62
	Towns	Males	1,655	1,265	1,105	660	485	310	22·29	21·42	23·34	23·98	25·77	25·80
		Females	1,375	1,185	1,110	540	450	270	19·53	18·47	15·37	15·70	19·20	14·24
		Both sexes	3,030	2,450	2,215	1,200	935	580	21·05	20·02	19·26	20·17	22·53	20·34
	Villages	Males	3,840	2,250	2,510	1,875	1,515	1,075	23·17	27·33	22·11	22·34	18·44	26·96
		Females	3,905	2,255	2,445	1,535	1,450	935	17·47	21·51	20·05	17·83	13·64	17·78
		Both sexes	7,745	4,505	4,955	3,410	2,965	2,010	20·30	24·41	21·09	20·31	16·10	22·69
Madana-palle	City	Males	2,707	1,709	1,484	1,213	703	521	9·97	16·22	22·42	26·84	35·69	65·66
		Females	2,419	1,762	1,559	897	576	436	5·95	16·82	20·42	27·94	34·34	35·24
		Both sexes	5,126	3,471	3,043	2,110	1,279	957	8·07	16·53	21·40	27·24	35·08	51·80

	Towns	Males	1,870	1,352	1,246	1,029	690	535	6·16	14·24	28·27	46·02	82·12	78·27
		Females	1,891	1,257	1,270	789	577	449	3·28	8·24	16·07	26·98	38·52	53·84
		Both sexes	3,761	2,609	2,516	1,818	1,267	984	4·71	11·35	22·12	37·78	62·34	67·12
	Villages	Males	3,039	1,895	1,628	1,487	1,096	1,027	3·10	8·41	17·23	24·47	50·11	74·08
		Females	2,938	1,591	1,847	1,381	949	744	2·00	4·59	11·50	14·96	18·12	38·38
		Both sexes	5,977	3,486	3,475	2,868	2,045	1,771	2·56	6·66	14·18	19·89	35·27	59·09
Patna	City	Males	2,575	1,830	1,475	1,115	685	455	0·87	11·68	18·58	24·05	42·97	61·09
		Females	1,980	1,520	1,415	875	650	395	10·63	17·32	19·50	34·83	35·85	42·69
		Both sexes	4,555	3,350	2,890	1,990	1,335	850	9·63	14·23	19·03	28·79	39·50	52·54
	Towns	Males	1,780	1,160	1,050	715	505	355	5·66	18·79	29·72	26·72	45·70	46·53
		Females	1,490	820	735	620	390	260	5·91	20·91	25·66	23·44	25·76	34·34
		Both sexes	3,270	1,980	1,785	1,335	895	615	5·78	19·67	28·06	24·86	37·05	41·45
	Villages	Males	2,450	1,305	1,355	1,050	700	595	4·40	11·51	16·46	27·56	43·18	50·49
		Females	1,900	1,100	1,300	825	760	480	5·10	9·32	9·85	13·01	33·01	48·55
		Both sexes	4,350	2,405	2,655	1,875	1,460	1,075	4·70	10·51	13·22	21·16	37·89	49·63
Trivan-drum	City	Males	3,185	1,585	1,155	695	685	545	11·28	6·21	10·27	24·69	34·17	67·13
		Females	3,080	1,895	1,415	1,035	760	630	17·79	8·47	9·33	18·11	19·16	31·05
		Both sexes	6,265	3,480	2,570	1,730	1,445	1,175	11·48	7·46	9·75	20·75	26·28	47·78
	Towns	Males	1,165	840	695	460	320	340	17·28	9·58	18·89	33·98	40·25	40·52
		Females	1,180	735	680	590	285	305	22·81	9·62	16·24	21·98	31·94	33·74
		Both sexes	2,345	1,575	1,375	1,050	605	645	20·06	9·60	17·58	27·26	36·34	37·31
	Villages	Males	6,340	3,955	3,220	2,465	1,830	1,595	12·99	6·58	14·37	20·98	27·66	38·57
		Females	6,575	3,855	3,680	2,390	1,585	1,310	13·51	6·12	12·11	11·07	15·31	29·39
		Both sexes	12,915	7,810	6,900	4,855	3,415	2,905	13·26	6·35	13·16	16·11	22·86	34·43

Table 6·5

Number of bacillary cases per 1,000 x-rayed by age and sex.

Zone	Nature of area	Sex	Population x-rayed by age groups						Number of bacillary cases per 1000 x-rayed					
			5—14	15—24	25—34	35—44	45—54	55 & above	5—14	15—24	25—34	35—44	45—54	55 & above
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Calcutta	City	Males	2,295	2,810	2,195	1,285	755	710	2·58	4·48	6·05	8·43	11·84	28·81
		Females	1,855	1,415	1,210	720	455	450	0·99	7·14	7·50	5·40	7·12	6·84
		Both sexes	4,150	4,225	3,405	2,005	1,210	1,160	1·87	5·37	6·57	7·34	10·06	20·28
Delhi	City	Males	3,015	2,885	3,205	1,865	1,010	765	0·19	2·28	6·95	6·75	15·29	8·06
		Females	2,660	2,600	2,290	1,065	745	675	0·43	3·97	4·63	2·03	1·91	4·72
		Both sexes	5,675	5,485	5,495	2,930	1,755	1,440	0·30	3·08	5·98	5·03	9·61	6·50
	Towns	Males	1,960	1,320	985	695	585	435	0·60	0·01	4·23	7·33	3·58	13·02
		Females	1,645	1,080	880	660	460	510	0·02	1·25	3·20	4·49	1·60	3·19
		Both sexes	3,605	2,400	1,865	1,355	1,045	945	0·34	0·55	3·74	5·96	2·68	7·63
	Villages	Males	4,270	2,590	1,970	1,795	1,255	1,580	0·29	0·43	4·58	2·94	9·68	7·25
		Females	3,340	2,595	2,030	1,535	1,120	995	0·66	0·79	3·12	2·64	2·85	4·50
		Both sexes	7,610	5,185	4,000	3,330	2,375	2,575	0·45	0·61	3·84	2·80	6·46	6·19
Hydera-bad	City	Males	5,125	3,205	2,555	1,765	1,200	1,030	1·24	2·15	6·91	6·97	14·71	17·56
		Females	4,625	3,220	2,680	1,655	1,150	1,030	0·78	4·04	3·63	3·98	3·69	6·22
		Both sexes	9,750	6,425	5,235	3,420	2,350	2,060	1·02	3·09	5·23	5·52	9·31	11·89
	Towns	Males	1,655	1,265	1,105	660	485	310	2·29	3·41	5·86	7·40	8·45	3·49
		Females	1,375	1,185	1,110	540	450	270	2·12	2·50	1·61	1·74	5·86	0·37
		Both sexes	3,030	2,450	2,215	1,200	935	580	2·22	2·98	3·68	4·80	7·17	2·02
	Villages	Males	3,840	2,250	2,510	1,875	1,515	1,075	1·73	2·30	2·33	4·36	4·46	5·31
		Females	3,905	2,255	2,445	1,535	1,450	935	1·02	2·16	1·10	2·41	1·12	3·72
		Both sexes	7,745	4,505	4,955	3,410	2,965	2,010	1·37	2·23	1·72	3·48	2·83	4·57
Madana-palle	City	Males	2,707	1,709	1,484	1,213	703	521	0·75	1·37	4·30	2·75	3·05	6·20
		Females	2,419	1,762	1,559	897	576	436	0·43	4·04	2·73	3·78	3·49	2·64
		Both sexes	5,126	3,471	3,043	2,110	1,279	957	0·59	2·72	3·50	3·19	3·25	4·58

	Towns	Males	1,870	1,352	1,246	1,029	690	535	0·09	6·70	10·35	18·78	33·21	26·98
		Females	1,891	1,257	1,270	789	577	449	0·20	3·52	3·15	12·66	6·68	9·35
		Both sexes	3,761	2,609	2,516	1,818	1,267	984	0·15	5·17	6·72	16·13	21·18	18·93
	Villages	Males	3,039	1,895	1,628	1,487	1,096	1,027	0·38	4·41	7·57	12·28	20·20	23·23
		Females	2,938	1,591	1,847	1,381	949	744	0·65	2·31	4·27	5·18	4·71	11·58
		Both sexes	5,977	3,486	3,475	2,868	2,045	1,771	0·51	3·45	5·81	8·86	13·01	18·34
Patna	City	Males	2,575	1,830	1,475	1,115	685	455	0·30	6·67	11·43	6·55	10·82	11·65
		Females	1,980	1,520	1,415	875	650	395	0·99	5·68	9·50	2·42	5·22	5·29
		Both sexes	4,555	3,350	2,890	1,990	1,335	850	0·62	6·26	10·64	4·65	8·39	9·00
	Towns	Males	1,780	1,160	1,050	715	505	355	0·29	6·67	11·52	6·81	11·29	11·83
		Females	1,490	820	735	620	390	260	0·94	5·99	9·77	2·32	4·86	2·64
		Both sexes	3,270	1,080	1,785	1,335	895	615	0·59	6·24	10·60	4·53	8·87	7·66
	Villages	Males	2,450	1,305	1,355	1,050	700	395	0·93	5·72	6·10	10·73	19·57	16·30
		Females	1,900	1,100	1,300	825	760	480	0·60	4·15	4·72	3·80	10·97	10·21
		Both sexes	4,350	2,405	2,655	1,875	1,460	1,075	0·78	5·00	5·42	7·63	15·09	13·59
Trivan-drum	City	Males	3,185	1,585	1,155	695	685	545	0·91	1·55	1·73	5·88	13·26	18·64
		Females	3,080	1,895	1,415	1,035	760	630	1·45	1·49	1·26	5·26	4·10	4·19
		Both sexes	6,265	3,480	2,570	1,730	1,445	1,175	1·18	1·52	1·47	5·51	8·44	9·50
	Towns	Males	1,165	840	695	460	320	340	1·26	1·28	5·14	5·17	15·89	1·44
		Females	1,180	735	680	590	285	305	2·10	2·69	0·26	5·51	7·69	0·29
		Both sexes	2,345	1,575	1,375	1,050	605	645	1·68	1·94	2·73	5·36	12·03	0·90
	Villages	Males	6,340	3,955	3,220	2,465	1,830	1,595	1·04	0·94	6·60	6·61	6·35	7·44
		Females	6,575	3,855	3,680	2,390	1,585	1,310	0·33	0·76	2·39	1·17	2·45	5·69
		Both sexes	12,915	7,810	6,900	4,855	3,415	2,905	0·68	0·85	4·35	3·93	4·54	6·65

Table 6·6

Morbidity indices for population groups living in different types of houses.

Zone	Nature of area	Number x-rayed				Active & probably active cases per 1,000 x-rayed				Bacillary cases per 1,000 x-rayed			
		Hut	Kucha house	Pucca house	Total	Hut	Kucha house	Pucca house	Total	Hut	Kucha house	Pucca house	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Calcutta	City	—	4,065	12,090	16,155	—	23·07	14·60	16·73	—	9·33	5·40	6·39
Delhi	City	620	1,260	20,900	22,780	34·09	33·79	19·36	20·56	8·77	10·32	3·54	4·06
	Towns	30	2,545	8,640	11,215	18·22	18·46	12·06	13·47	0·00	3·62	2·14	2·45
	Villages	90	18,775	6,210	25,075	15·90	13·60	13·22	13·51	0·00	2·55	2·34	2·49
Hyderabad	City	1,000	13,210	15,030	29,240	23·74	20·26	10·65	15·44	6·11	5·38	3·03	4·18
	Towns	2,285	6,905	1,220	10,410	15·31	23·03	12·83	20·42	2·75	3·97	1·32	3·44
	Villages	3,645	21,165	780	25,590	21·67	20·76	20·51	20·88	1·84	2·29	4·41	2·29
Madanapalle	City	310	11,904	3,624	15,986	15·24	20·62	16·99	19·75	3·26	2·91	0·73	2·40
	Towns	3,924	1,902	7,108	12,955	26·30	22·81	23·24	24·35	10·27	4·16	7·73	8·13
	Villages	11,664	4,358	3,572	19,622	15·88	16·66	17·41	16·39	6·11	5·83	6·19	6·11
Patna	City	—	7,570	7,400	14,970	—	22·37	17·82	20·12	—	6·92	5·82	6·38
	Towns	5	5,105	4,770	9,880	—	21·55	18·82	20·22	—	6·02	4·45	5·25
	Villages	—	13,130	690	13,820	—	16·69	14·45	16·58	—	5·94	4·11	5·85
Trivandrum	City	1,280	8,765	6,620	16,665	15·28	18·25	13·95	16·31	4·50	3·55	1·89	2·96
	Towns	1,605	3,645	2,345	7,595	20·55	21·17	21·72	21·21	2·25	2·76	4·63	3·20
	Villages	13,090	18,640	7,070	38,800	16·36	13·67	14·00	14·64	3·46	2·17	2·05	2·59

Table 6·7

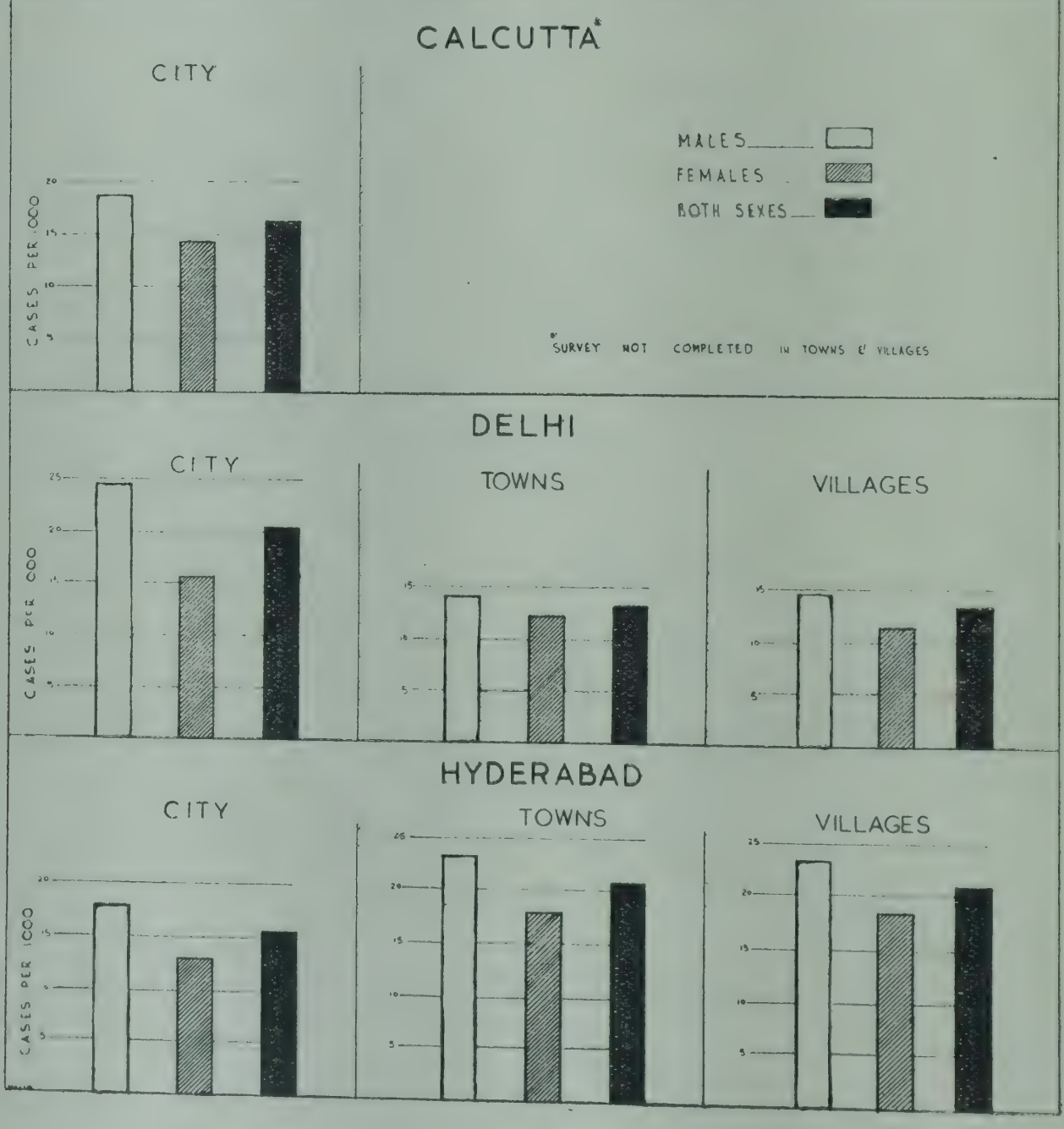
Distribution of 'active' and 'probably active' cases according to extent of disease and cavitation.

Zone	Nature of area	Percentage of cases classified according to extent of disease as				Percentage of cases classified according to cavitation as		
		Minimal	Moderately advanced	Far advanced	Others	Nil	Doubtful	Present
Calcutta	City (Calcutta)	10·0	62·7	15·5	11·8	81·8	10·9	7·3
Delhi	City (Delhi)	11·7	43·6	36·2	8·5	71·3	11·7	17·0
	Towns	3·7	66·7	25·9	3·7	48·1	18·5	33·3
	Villages	7·7	59·0	25·6	7·7	67·9	16·7	15·4
Hyderabad	City (Hyderabad)	6·5	45·2	29·0	19·4	77·4	7·1	15·5
	Towns	6·3	46·8	30·4	16·5	74·7	10·1	15·2
	Villages	3·6	56·9	30·5	9·0	62·3	15·0	21·6
Madanapalle	City (Bangalore)	1·5	80·9	10·3	7·4	79·4	14·7	5·9
	Towns	5·4	54·5	30·9	9·1	69·1	16·4	14·5
	Villages	7·1	54·3	32·8	5·7	65·7	14·3	20·0
Patna	City (Patna)	5·2	50·0	29·3	15·5	64·6	16·4	19·0
	Towns	7·1	51·2	31·0	10·7	64·3	14·3	21·4
	Villages	—	—	66·7	33·3	33·3	33·3	33·3
Trivandrum	City (Trivandrum)*	25·0	45·8	12·5	16·7	87·5	8·3	4·2
	Towns	11·5	38·5	19·2	30·8	65·4	13·5	21·2
	Villages	6·2	44·2	30·2	19·4	61·2	15·5	23·3

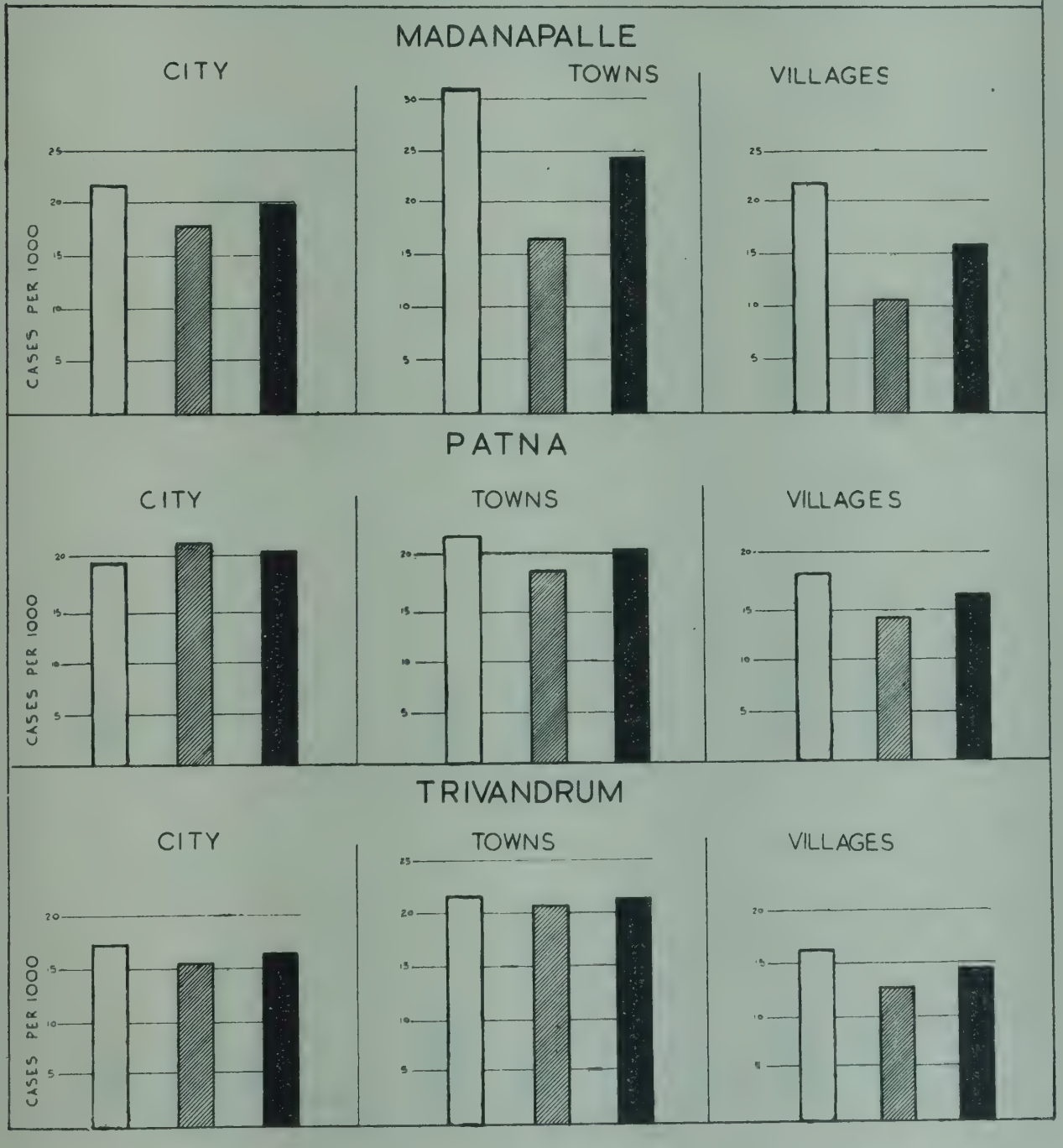
* Percentage based on small numbers.

CHART I

NUMBER OF ACTIVE CASES PER 1000



AND PROBABLY ACTIVE X-RAYED BY SEX



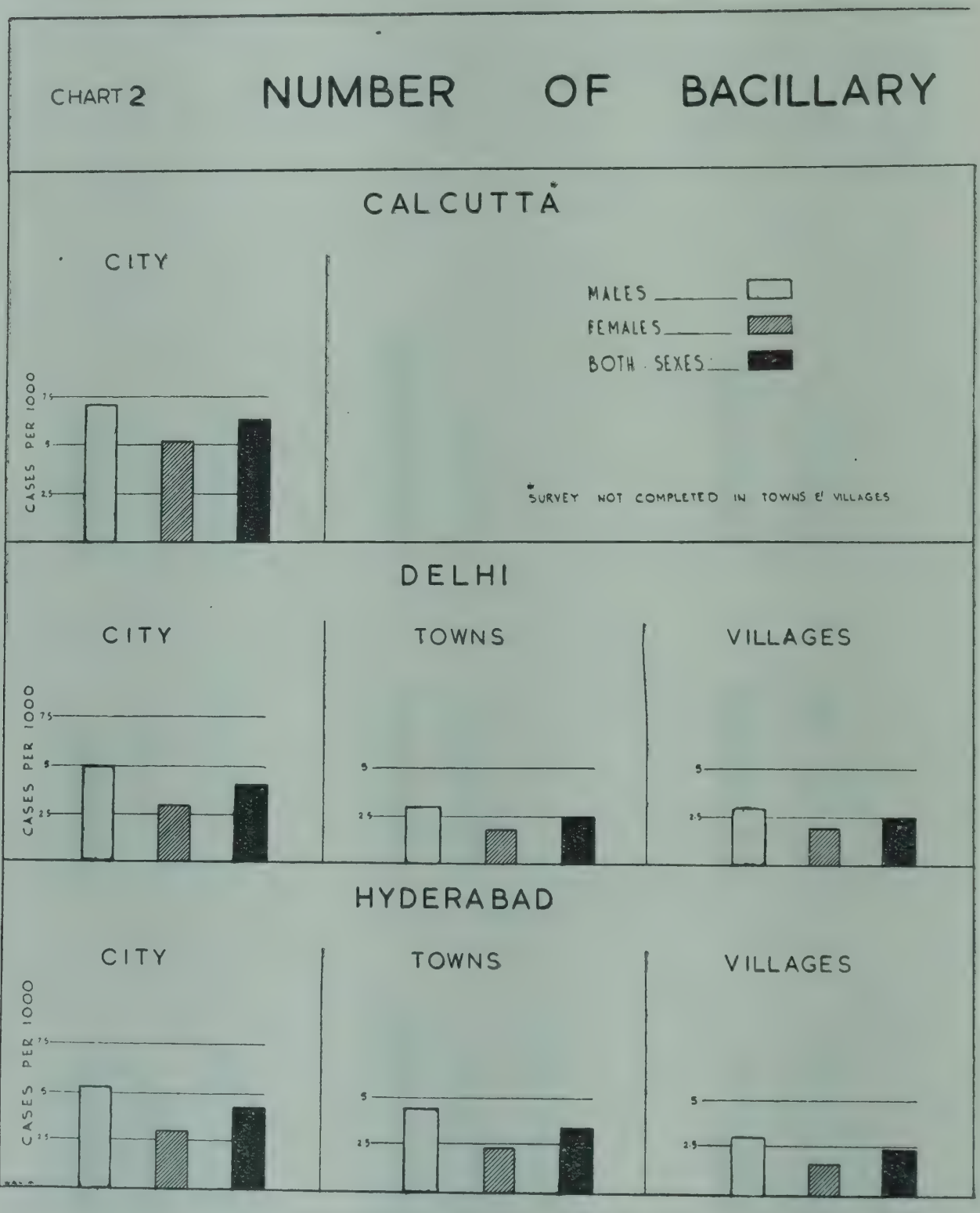


CHART 2
NUMBER OF BACILLARY
CALCUTTA*
CITY
MALES
FEMALES
BOTH SEXES
CASES PER 1000
7·5
5
2·5
*SURVEY NOT COMPLETED IN TOWNS & VILLAGES
DELHI
CITY
TOWNS
VILLAGES
HYDERABAD
CITY
TOWNS
VILLAGES

CASES PER 1000 X-RAYED BY SEX

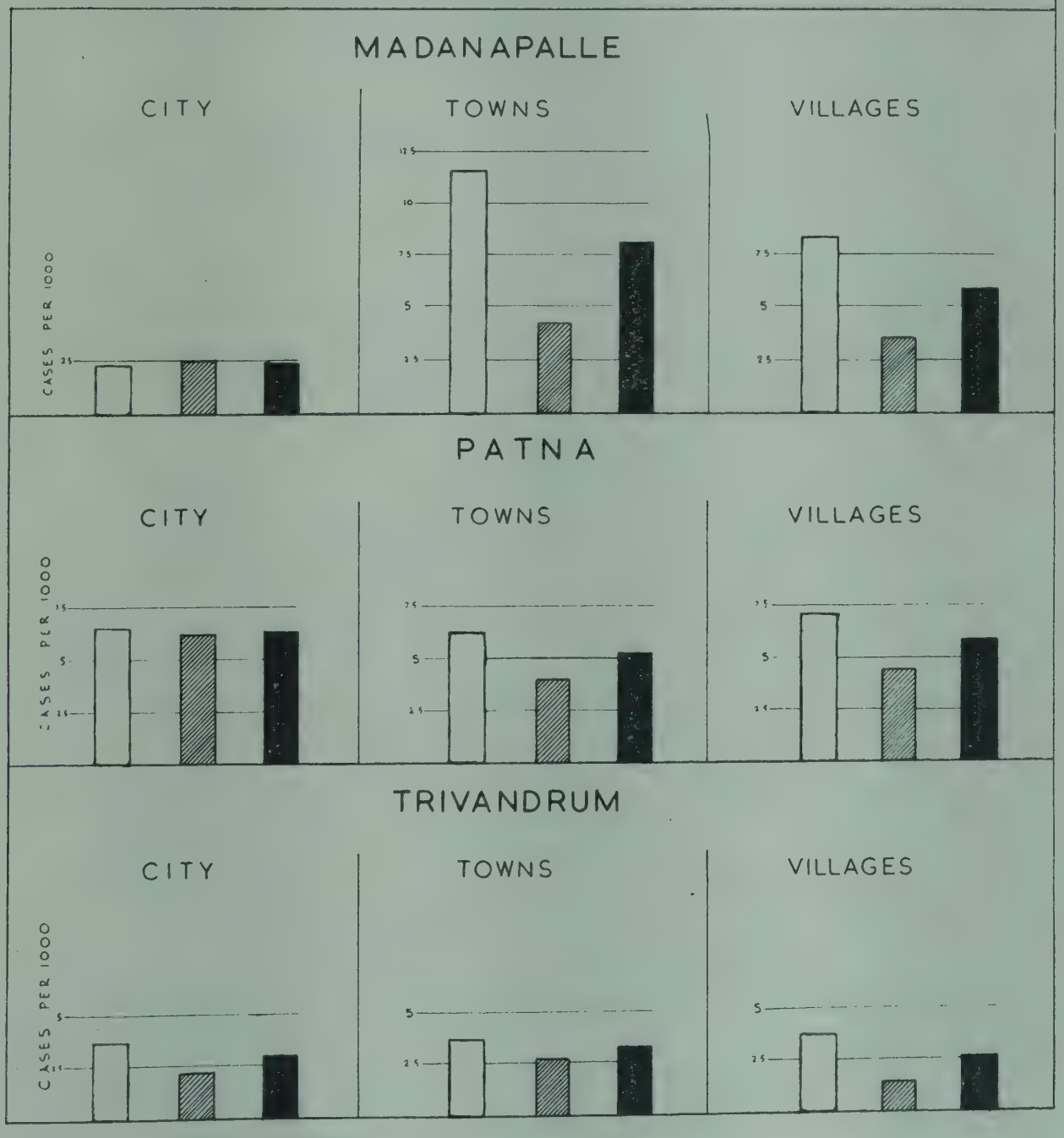
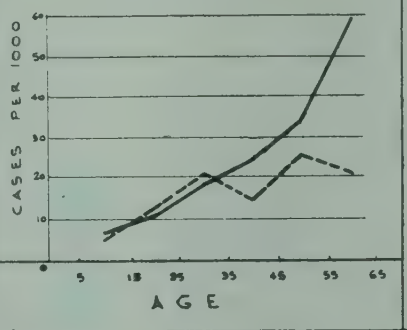


CHART 3

NUMBER OF ACTIVE AND PER 1000 X-RAYED

CALCUTTA*

CITY

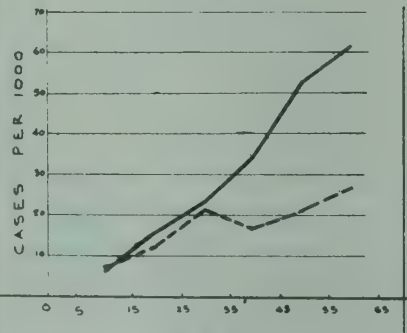


MALES ——
FEMALES - - - -

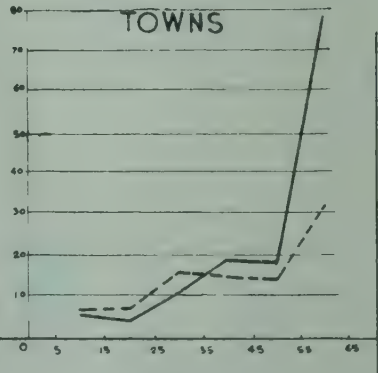
* SURVEY NOT COMPLETED IN TOWNS & VILLAGES

DELHI

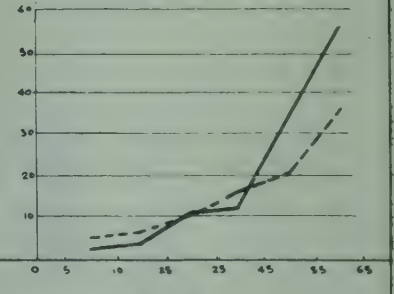
CITY



TOWNS

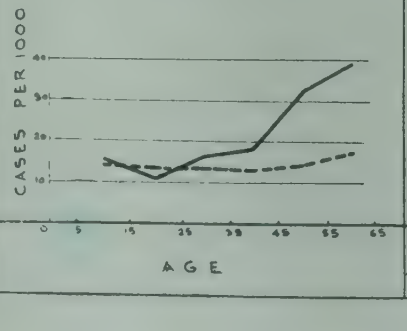


VILLAGES

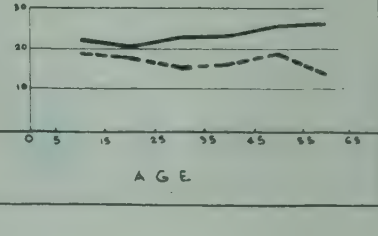


HYDERABAD

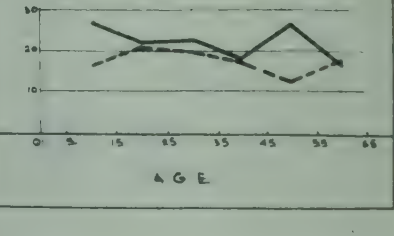
CITY



TOWNS



VILLAGES



PROBABLY ACTIVE CASES BY AGE AND SEX

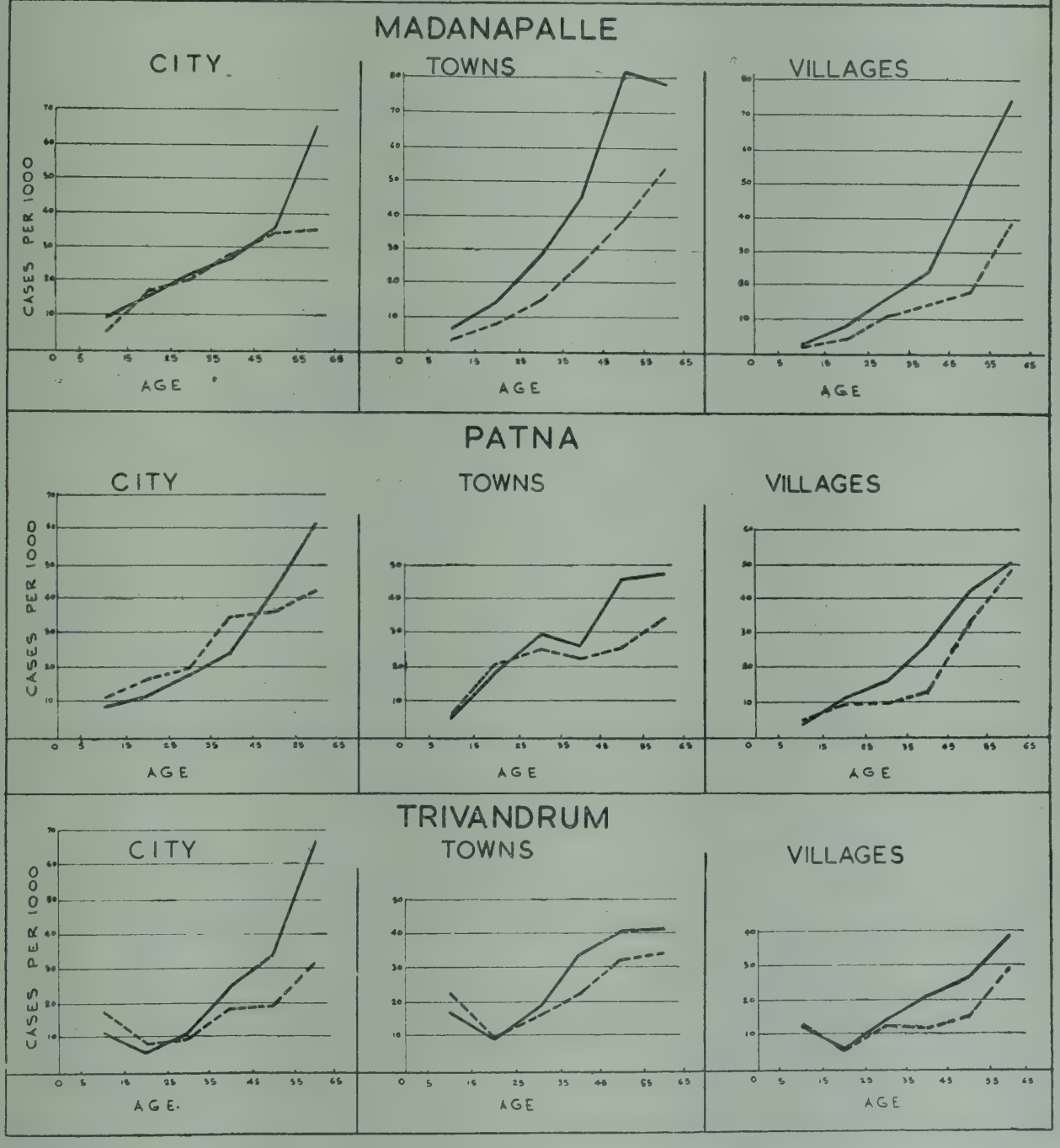
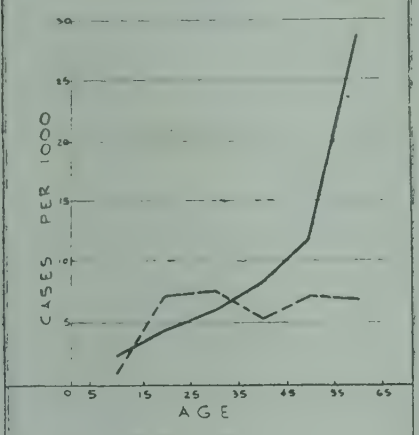


CHART 4

NUMBER OF BACILLARY X-RAYED BY

CALCUTTA*

CITY



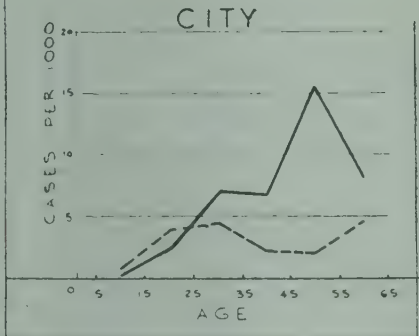
MALES ——

FEMALES - - - -

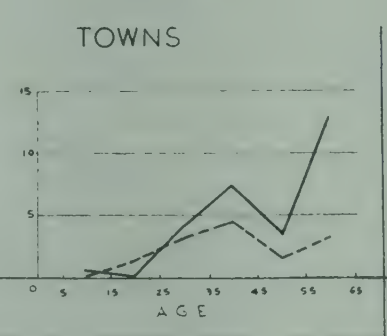
*SURVEY NOT COMPLETED IN TOWNS & VILLAGES

DELHI

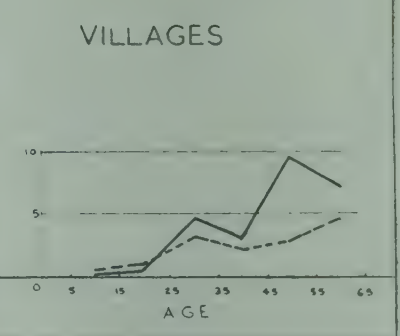
CITY



TOWNS

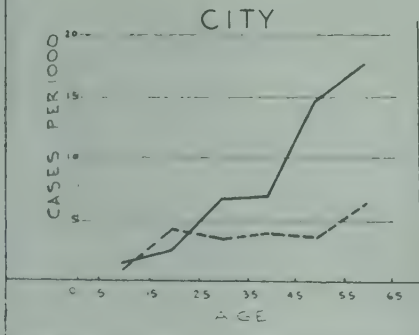


VILLAGES

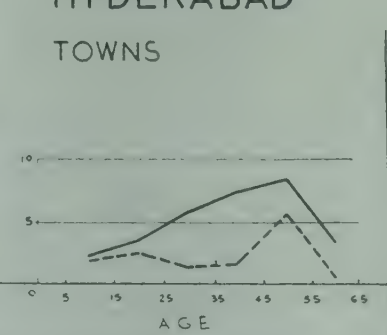


HYDERABAD

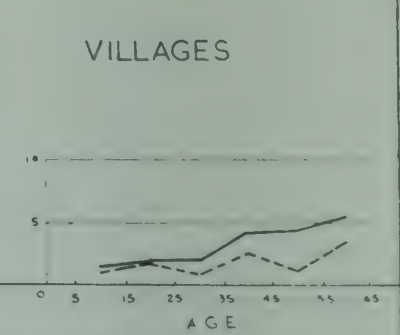
CITY



TOWNS



VILLAGES



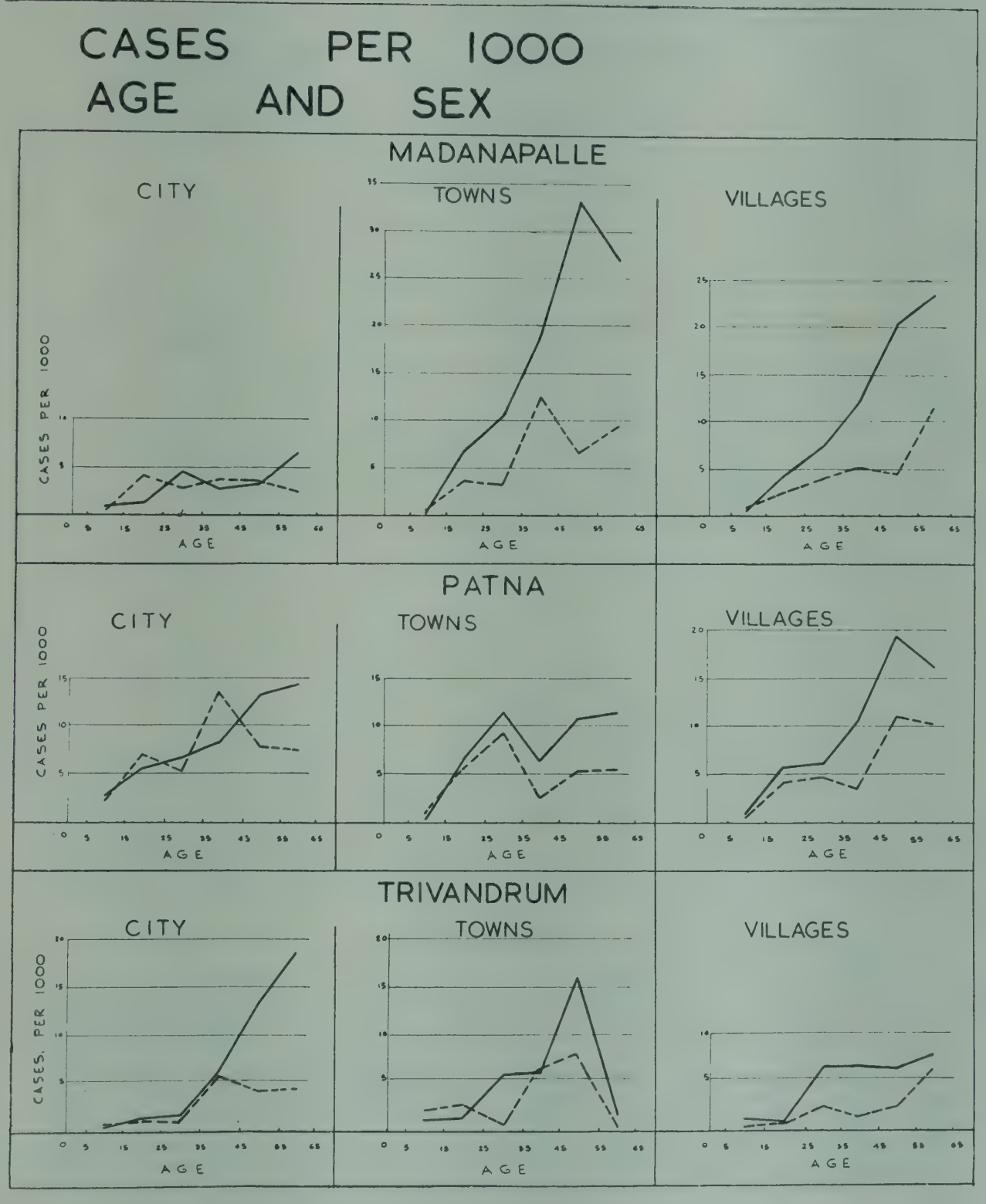
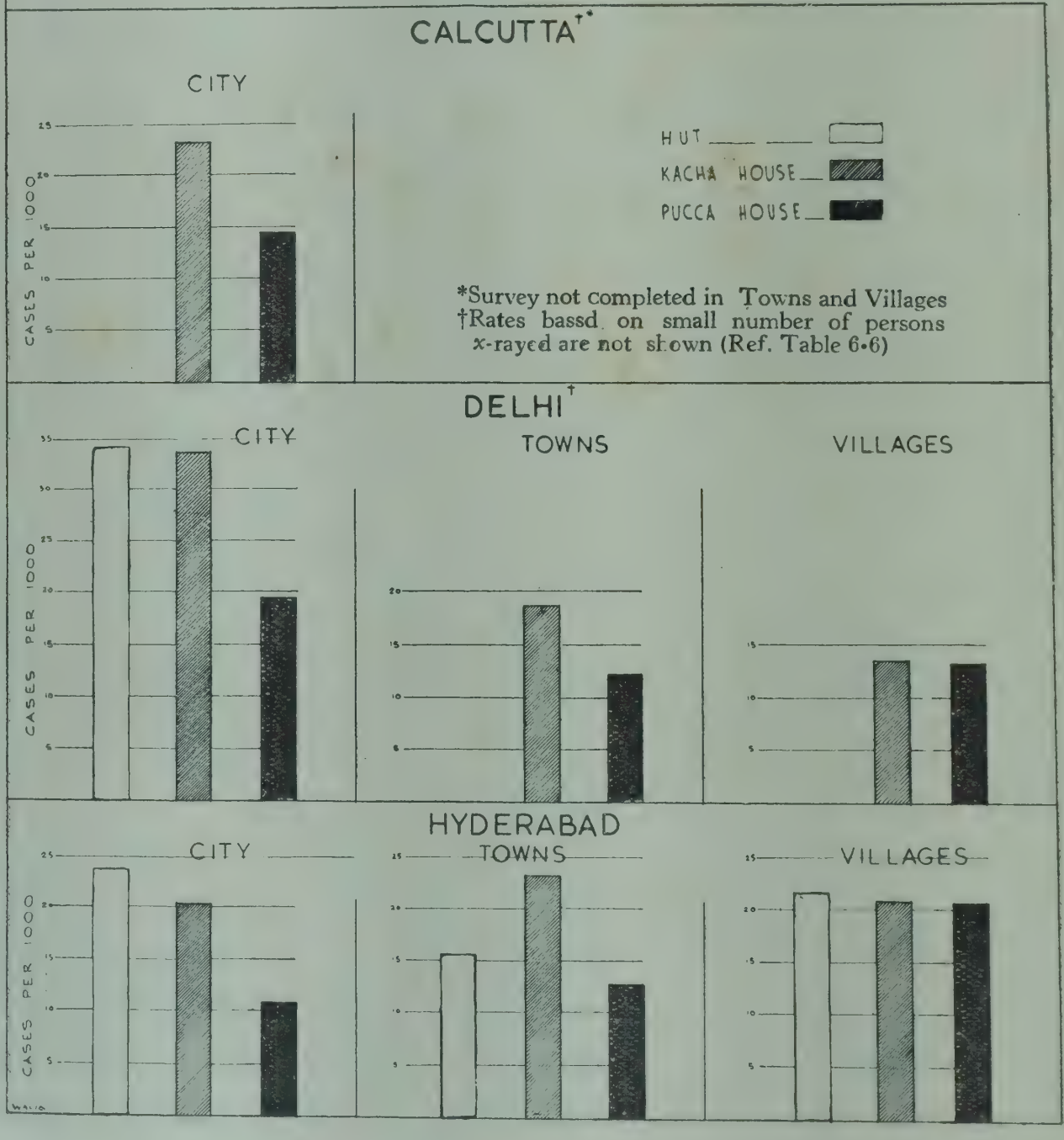

CASES PER 1000
AGE AND SEX
MADANAPALLE
CITY
TOWNS
VILLAGES
CASES PER 1000
AGE
PATNA
CITY
TOWNS
VILLAGES
CASES PER 1000
AGE
TRIVANDRUM
CITY
TOWNS
VILLAGES
CASES. PER 1000
AGE

CHART 5

NUMBER OF ACTIVE AND X-RAYED ACCORDING



PROBABLY ACTIVE CASES PER 1000 TO TYPE OF HOUSE

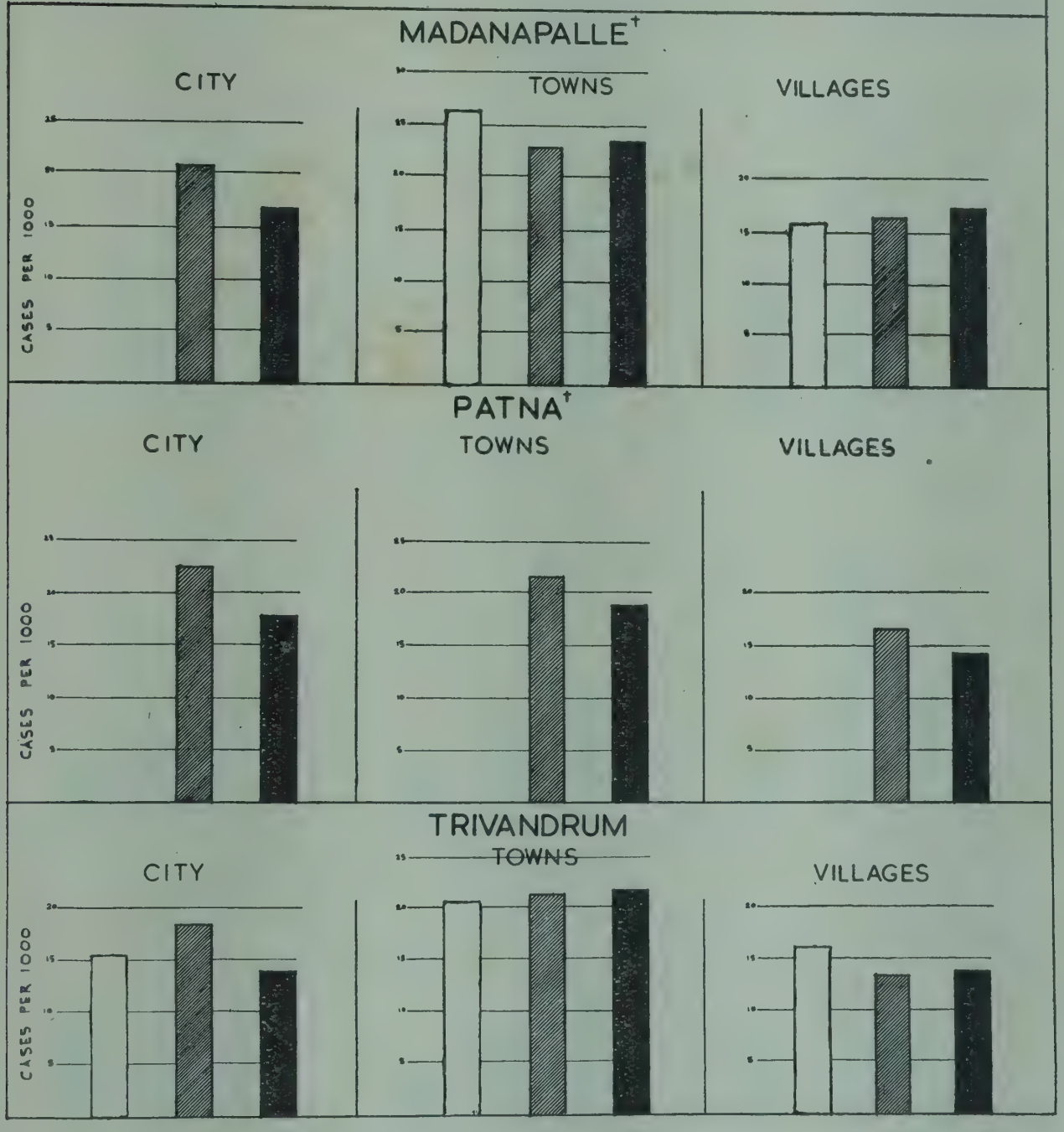
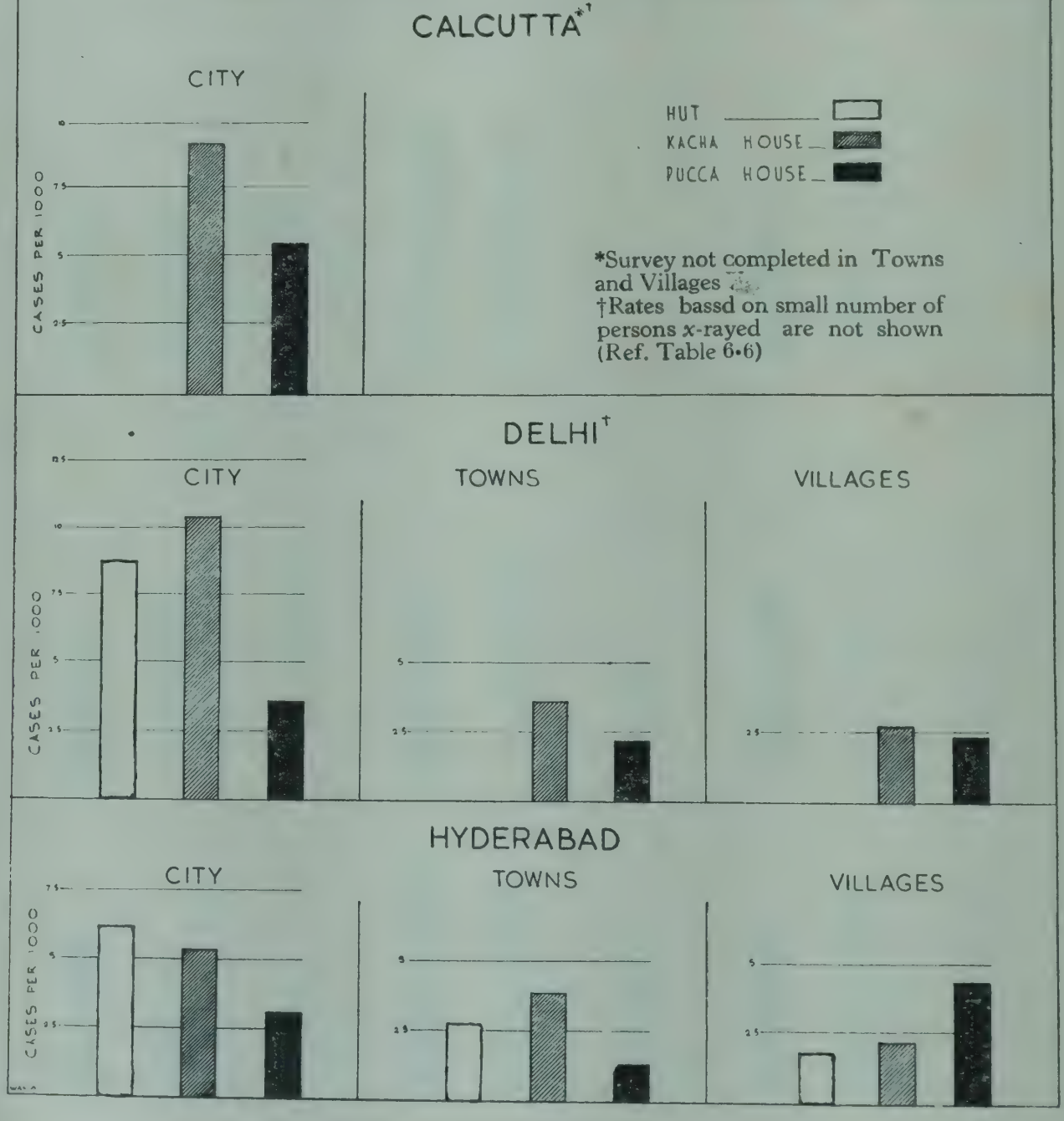
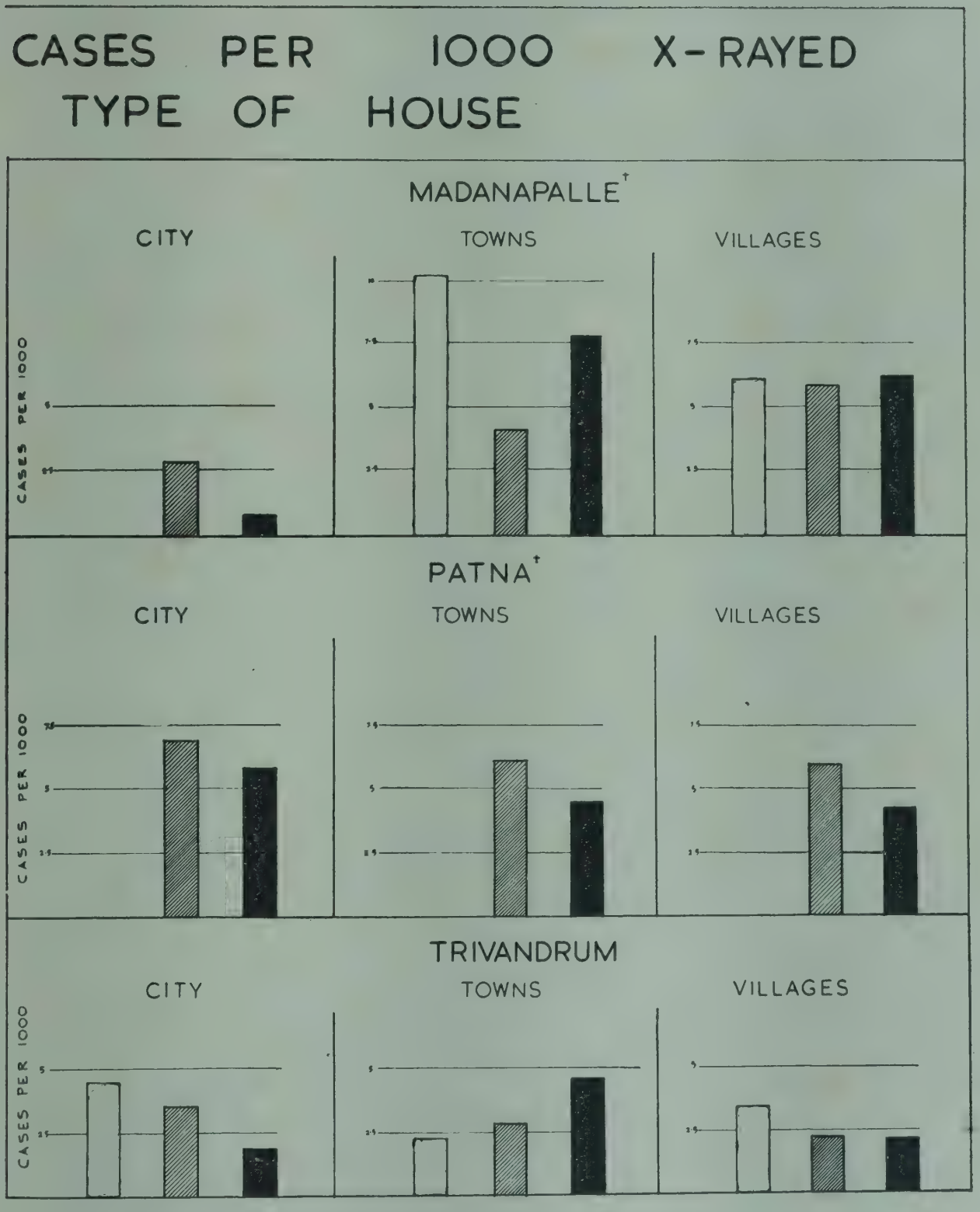


CHART 6

NUMBER OF BACILLARY ACCORDING TO




CASES PER 1000 X-RAYED
TYPE OF HOUSE
MADANAPALLE†
CITY
TOWNS
VILLAGES
CASES PER 1000
PATNA†
CITY
TOWNS
VILLAGES
CASES PER 1000
TRIVANDRUM
CITY
TOWNS
VILLAGES
CASES PER 1000

(*f*) Discussion

The survey has shown that the differences, if any, in morbidity rates between cities, towns and villages are much smaller than what was expected. Though the incidence of tuberculosis in rural areas is generally lower than that in cities and towns, the difference is not marked. This finding, though disturbing, may have some reasons. A deeper understanding of the ecological features of our cities and towns, and of the closeness of contact between urban and rural populations may be necessary before we can find an explanation. The present survey has also shown that there are areas within a city where the prevalence of tuberculosis may be as high as 4 or 5 per cent and that these are generally the areas occupied by the poorest of the population. They are living very often in extremely insanitary conditions. When we think of tuberculosis being high in cities there is a chance of taking for granted that the majority of the population lives under such conditions. Since sections of the community living in healthier surroundings have got lesser prevalence, they make the average prevalence in the city less than what we expect.

It has also to be recognised that not only at the present time, but from times immemorial, the rural populations were undertaking long treks to distant parts of the country, to attend fairs and festivals. This naturally leads to dissemination of the disease. Such dissemination can be expected to be higher in areas near channels of communication. As the survey has covered only accessible villages so far, the prevalence rates obtained are applicable only to such rural areas where this dissemination is likely to be more. Further investigation is necessary to ascertain whether the conditions will be different in the inaccessible rural areas.

Another factor that is noted was that the majority of cases suffering from tuberculosis were moderately advanced and that minimal cases were few. It was also noted that cavitary cases were less in the cities than in small towns. It is not easy to explain these differences. But one possible explanation is that in cities there are more facilities for treatment and the more advanced cases, especially those with symptoms, may have had chance to be treated with modern anti-bacterial drugs.

The sample survey covered only forty per cent of the total population of the country spread over six zones. Even in these zones, not all sections of the population could be included partly because of difficulties of transporting the *x*-ray vans in the absence of satisfactory road communications, and partly because of financial limitations. The survey has provided estimates of disease prevalence only for the largest city, medium sized towns and accessible villages in each zone. It is, therefore, not justifiable to use this data to estimate the total number of tuberculosis cases in the country. However, the survey provides enough evidence that the total number of pulmonary tuberculosis cases in the country is much larger than what was assumed previously and is likely to be in the neighbourhood of about five million *i.e.* 1·3 per cent of the total population. Not all of these 'cases' would

necessarily require treatment as some may, after continued observation, prove to be not needing special attention. But a certain proportion of these 5 million tuberculosis cases would be excreting bacilli and would thus be infecting other persons. From the results of the survey it is reasonable to assume that the number of such infectious cases in the country would be at least 1·5 million *i.e.* 0·4 per cent of the population. The existence of such a large number of infectious tuberculosis cases spread over the urban and rural areas in the different parts of the country is obviously a matter for serious concern and demands a very high priority for the anti-tuberculosis campaign in the country's plans.

The above findings also make it necessary to review our methods for controlling tuberculosis in the country. Till now the main emphasis was being given to the control of tuberculosis in urban and crowded areas, as these were considered to be the important centres where tuberculosis was concentrated. There is undoubtedly much tuberculosis in cities. But these are usually concentrated in certain areas of the cities where the economic condition of the people is comparatively poor. When priorities are to be given because of paucity of funds and personnel, it would naturally be necessary to concentrate tuberculosis control measures in these areas *e.g.* if only a few clinics can be started in a city it is well to have them located in such areas. Since tuberculosis is now known to be fairly high in the rural areas also, especially the 'accessible' villages* we have to think of extending anti-tuberculosis measures to these areas along with the introduction of measures in urban areas. This increases manifold the magnitude of the tuberculosis control programme. It seems necessary, therefore, that the control of tuberculosis in rural areas has to form a significant part in the tuberculosis control programme in the Third and subsequent Five Year Plans.

* At the time of writing this report, part of the survey in the 'inaccessible' villages has been completed. The preliminary results indicate that there is no significant difference regarding the tuberculosis incidence in the 'accessible' and 'inaccessible' rural areas now surveyed.

APPENDIX 1

Manual of Instructions

Introduction

This survey will be confined to the following seven zones demarcated around the existing Tuberculosis Centres with mobile *x*-ray equipment.

Name of zone	Areas included	Population (1951 Census)
1. Calcutta	Districts of West Bengal south of the River Ganga and the districts of Mayurbhanj, Balasore and Keonjhar of Orissa State.	23,844,000
2. Delhi	States of Punjab, PEPSU and Delhi and districts of Saharanpur, Muzaffarnagar, Meerut, Bulandshahr, Aligarh, Mathura of Uttar Pradesh.	28,691,000
3. Hyderabad	Hyderabad State, and districts of Sholapore, Bijapur, Belgaum, Dharwar and Kanara of Bombay State.	25,377,000
4. Madanapalle	Districts of Andhra State south of River Krishna, Mysore State and North Arcot district of Madras State.	23,148,000
5. Madras	Madras State excluding the districts of North Arcot, South Kanara, Malabar, Nilgiris, and Tinnevelly.	23,610,000
6. Patna	Districts of Bihar State south of the River Ganga.	21,554,000 (approximate)
7. Trivandrum	States of Travancore-Cochin and Coorg, and districts of South Kanara, Malabar, Nilgiris, Tinnevelly of Madras State.	18,775,000

Within each zone the areas to be surveyed will consist of (*a*) about 30 villages, (*b*) a few blocks in six medium-sized towns and (*c*) a few blocks in a city. The entire resident population above 5 years of age in these areas will be included in the survey which will consist of a miniature *x*-ray followed by bacteriological

examination whenever necessary. The procedure to be followed is given below under the following headings :

(A) Mass *x*-ray.
(B) Reading of films.
(C) Bacteriological examination.

A. MASS *X*-RAY

1. Selection of villages

1·1. For the purpose of this survey a specified *village* will cover the entire area included under that name in the 1951 Census. It would normally refer to the revenue village and may include, in addition to the main village, smaller villages or hamlets (collection or group of houses). Of these an *accessible village* is defined as one where the main part of the village is within half a mile of a road negotiable by the mobile *x*-ray and generator vans. The presumption is that people from the more distant parts will not mind covering somewhat longer distances, as they have often to go to the main village.

1·2. A list of 120 villages would have been given to each unit by Dr. C. Chandrasekaran, Professor of Statistics, All-India Institute of Hygiene and Public Health, Calcutta to provide a frame from which 30 accessible villages should be selected. The accessibility or otherwise of each of these 120 villages will have to be ascertained, as far as possible, by a responsible official of each centre by personally visiting the villages. Where information from District Medical Officers, Tehsildars or Regional Officers of the National Sample Survey are used the decision on accessibility or otherwise should be supported by at least two independent agencies.

1·3. If the number of accessible villages is about 30 (say 28 to 32) all these villages should be included in the survey. If their number is more than 32 a statistician has to be consulted for selecting at random 30 of these villages for the survey. In any case, the list of accessible villages and that of the finally selected villages should be sent to Dr. Chandrasekaran. If, however, the number of accessible villages is less than 28 a further list of villages will have to be obtained from him and information regarding accessibility of these new villages will have to be ascertained in the same manner. While asking for the new list the names of accessible villages in the original list should be supplied.

1·4. In order to secure uniformity, the different centres should follow strictly the definition of accessibility given above and the information will have to be obtained through personal visits by responsible officials of each centre.

2. Selection of blocks within towns.

2·1. A list of six towns will be supplied to each centre. Roughly ten per cent of the population living within the present boundaries of each of these towns has to be surveyed. The process of selection should be as follows.

2·2. The town has to be divided into more or less equal blocks, at least 30 in number, each consisting of 100 to 150 households (population about 500 to 750) with well-defined boundaries. The census blocks (full information about which would be available from the National Register of Citizens kept at the Municipal Committees) can be used for this purpose. If, however, some of the census blocks are too big or too small they have to be sub-divided, or clubbed together to form new blocks of the size specified above. Any extensions in the towns outside the 1951 Census blocks should be treated as new blocks if they are big enough or amalgamated with adjacent blocks if small. In any case a statistician should be consulted for the purpose of forming these blocks. Ten per cent of these blocks should then be chosen at random to form the sample to be surveyed. This selection should be made as shown by the following example. Suppose there are 54 blocks in all of which we have to select 10 per cent. Randomise the blocks and number them from 1 to 54. Choose at random a number from 1 to 10, say 6. Then the blocks No. 6, 16, 26, 36, and 46 form the sample. If, however, the number 3 came up instead of 6, there would be six blocks to be surveyed *viz.*, 3, 13, 23, 33, 43, and 53.

3. Selection of blocks within cities

3·1. The name of the city to be surveyed would have been given to each unit. The process of selecting blocks within the city for survey should be as follows.

3·2. Divide the city, taking the present boundaries, into more or less equal blocks in the same manner as was adopted in the case of towns ; but the block size in this case may be slightly bigger—160 to 200 households or 800 to 1,000 population. From these blocks about 25 to 40 blocks will have to be selected purely at random for the survey.

4. Census

4·1. The next step is to list the households in each village or block selected for survey and fill the Household Schedules (See page 79).

4·2. *A household* for our purpose, is defined as a group of persons normally living together (in a dwelling unit) and having a common cooking arrangement. However, lodgers who sleep in the dwelling unit and have no cooking arrangement within the dwelling unit should also be included in the houshold. Thus it is possible to have more than one household in the same house.

4·3. *The head of the household* is the person usually so regarded by the rest of the family, not necessarily the bread winner.

4·4. Each household has to be given (according to a definite system) a number which should be written in a prominent place. The main purpose of this numbering is to locate the household at the time of the survey. In the larger villages clusters of houses could be given subscripts like A, B, C, etc. and the houses within it serially numbered, like A1, A2, A3, ...B1, B2, B3, etc. The various households within

I.C.M.R. Tuberculosis Survey 1955—58. Zone..... Household No... .... Serial No.....

HOUSEHOLD SCHEDULE

District : ... .Tehsil, Taluk or Police Station :.....Village/Town..... | Type of house :.....

Locality/Ward :.....Street :..... ....House No..... | Religion :..... (of household)

S. No.	Name (Head of household first)	Relationship within household	Sex	Age	Occupation	Whether resident or visitor	Is any resident staying out temporarily ? If so, state reasons.	Is he/she ill ? If so, state nature of illness	Whether *x*-rayed or not	*X*-ray Sr. No. or reason if not *x*-rayed.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

A : If there is a case of tuberculosis in the household give particulars (whether staying in the house or in a hospital, period since ill, nature of treatment, if any, etc.) :—

B : Was there a death from tuberculosis in the household ? If so give particulars :—

Date..... *Signature*.....

each house could be marked A1/1, A1/2, A1/3 etc. To ensure that no households are omitted information about the number of households within each house should be obtained from the house visited. After numbering each household the enumerator should carefully fill all the entries in the Household Schedule, which should be filled at least in duplicate.

4·5. If any house is found locked at the time of this census a blank sheet of the Household Schedule will have to be kept for each of the households residing in that house (an information which may be obtained from the neighbouring house). The date or dates of visit and the remark 'locked' should be written on the right hand top corner of each Schedule. If the occupants of the house are reported to have come back they may be included in the census if the leader of the team is convinced, on enquiries, that they are genuine residents of the specified household.

4·6. The information for the Household Schedule should be obtained from a responsible member of the household—usually the head of the household, his wife or some other adult member of the family.

4·7. School hostels, boarding houses etc. should be enumerated as special households and should be included in the survey. Hospital wards, sanatoria, office, shops etc. should not be included in the survey and Household Schedules need not be filled for them. However, any household usually living on the premises of such establishments should be included in the census, as a common household, *e.g.*, household of resident medical superintendent, of the chowkidar living on the premises etc.

Note : If a person from a household to be surveyed is a patient in the local hospital or sanatorium, he will have to be included as a member of the household surveyed.

4·8. *Checking of Census.*—After the census a responsible member of the team should check enumerators' work for (*a*) completeness of coverage and (*b*) correctness of entries. About 3 per cent of the households should be checked and the types of mistakes found should be brought to the notice of the enumerator concerned in order to prevent their recurrence.

5. Filling the household schedules

5·1. Schedule should be filled legibly in ink (ballpoint pens are recommended).

5·2. Five digit numbers are printed serially on the schedules to be used in each zone. In addition to this the *Household number* (see para 4·4) should also be filled in the space provided in the schedule.

5·3. Separate sheets of the printed Schedule are to be used for each household. If more than one sheet is necessary the sheet with the next printed number should be used for continuation and appropriate remarks entered on the first and the continuation sheets.

5·4. Against '*Village/Town*' give the name of the village or town (Use the name given in the list of selected villages or town). If registers are used so that the

first copies of the Household Schedules can be left bound together, there is no need to repeat entries of District, Tehsil, Village/Town on every Household Schedule. It is enough if the first and last few schedules for the village or block of town bear all these common entries.

5·5. Against '*Type of house*' write hut, or kutcha (mud) house or pucca (brick, stone or cement) house.

5·6. Against '*Religion*' give that of all or the majority of the members of the household and in case some of the members are of a different religion note this fact against their names.

5·7. The particulars regarding each member of the household should be entered, starting with the head of the household, his wife, children (according to age) and others or servants last. In order to ensure that there are no omissions the questions should be put in a systematic manner covering each of the groups mentioned above.

5·8. *Col. 1—Serial numbers* are to be given to each member within each household. This is very important as this will form part of the reference number allotted to each person.

5·9. *Col. 2—Name* should be followed by father's name or husband's name in the case of married women. If the person has a nick name this should be entered within brackets after the name.

5·10. *Col. 3—Relationship within household* : Give, for example, son of serial number 1 or daughter of serial number 5 etc. as the case may be.

5·11. *Col. 4—Sex* : Use M for male and F for female.

5·12. *Col. 5*—Give *Age* in completed years.

5·13. *Col. 6—Occupation* : The entry in this column should clearly indicate the kind of work or nature of duties performed by the person. Entries such as 'farm-work', 'employed in factory', 'works in an office or in a shop' are vague since a farm worker may be (1) a farm labourer (2) a farm foreman supervising the work of a group of labourers, (3) a farm manager or (4) an owner or tenant cultivator ; a factory worker may be an assembler, moulder, fitter, lathe operator etc. While describing occupations the type of responsibility that a person has to bear and the type of skill that is required of him may be taken into account.

5·14. *Cols. 7 and 8.* (a) *Resident* is one who normally lives in the village. If such a person is staying out temporarily the reasons for his staying out should be stated in *col. 8.* It is of particular interest to know whether his absence is due to his undergoing treatment in a hospital or sanatorium. In such cases the nature of the institution and the address should be entered in the Schedule.

(b) A *Visitor* is a person who is temporarily staying with the household and who usually resides elsewhere. Thus, for example, a married daughter who normally lives with her husband outside the village or the selected blocks of a town but is temporarily staying with the household should be entered as a visitor. If, however, she is a resident of the same village or selected block of the town this fact should

be noted in both the Household Schedules and she should be *x*-rayed where available.

(*c*) If the entire household is only temporarily present in the dwelling unit and usually lives elsewhere all its members should be listed as visitors.

5·15. *Col. 9*—Give the symptoms and the reported diagnosis if any.

5·16. *Cols. 10 and 11*—These columns are to be filled in later on after *x*-ray and do not concern the census enumerator.

5·17. *Note A* (left bottom portion of Schedule)—Give particulars about cases of tuberculosis during the last five years in the household.

5·18. *Note B.* (right bottom portion of Schedule)—Give particulars regarding deaths from tuberculosis during the last five years in the household.

5·19. Against '*date*' give the date or dates of enumeration.

5·20. *Signature*—The enumerator should sign here on every page.

5·21. *Checking*—Finally scrutinise every relevant column or entry in the Schedule to ensure that they have all been filled properly. No column or space for entry should be left blank : wherever appropriate, 'Nil' and the symbol 'N.A.' (not applicable) should be given.

5·22. *Token*—After this scrutiny leave a token with the household and instruct the members to carry the token with them when they come to the *x*-ray van on the appointed day. This token may be a copy of the Household Schedule itself or separate token slips bearing the 'Ref. No.' of the person (see para 6·1)

5·23. At the end of the day's work the copies of the Schedule should be separated from the original which will be left in the register. The loose copies should be arranged according to the printed numbers on the Schedule and filed properly.

5·24. When the enumeration work has been completed for a village or block prepare an alphabetic index of names of heads of households showing against the head of each household the printed numbers on the schedule for that household. The name of father of the head of household should also be given for identification. This index will be helpful in identifying persons who come without the token for *x* ray.

6. Filling *X*-ray Cards

6·1. *X-ray Cards* should be prepared for each person five years of age or more in the household (whether resident present, resident absent or visitor), on the basis of the Household Schedules and should be ready when the *x*-ray work in the village or block starts. These cards should be arranged according to the *Ref. No.* in the *x*-ray card which should be written in two parts—the printed number on the schedule and the serial number of the person within the household (col. 1 of schedule). If more than one sheet of the Schedule has been used for a particular household the printed number on the first sheet should be used. Thus, if the Schedule with printed numbers 01046 and 01047 have been used for a particular

household and if the 16th member of this household is entered in the Schedule No. 01047 the Ref. No. of this person will still be 01046/16.

6·2. *'Contact history' and 'own history'* can be filled in on the basis of the information in col. 9 and Notes A and B on the Household Schedule.

6·3. X-ray No., date and the results of miniature *x*-ray and laboratory examinations on the reverse of the card are to be filled in subsequently.

6·4. It is important that all entries in the *x*-ray card should be complete and should be legibly filled in ink. No space for entry should be left blank (See para 5.21).

7. Mass X-ray.

7·1. *Start x*-ray work as soon after the census as possible.

7·2. The *aim* should be to *x*-ray 100 per cent of the population above 5 years of age in the village or in block. It is expected that sufficient number of persons will come up for *x*-ray on the first day. The fact that *x*-ray is going on at such and such a place should, however, be announced periodically in different parts of the village or block that can be taken up on that day. When the response tends to be poor, the members of the team should visit the house of the absentees (see para 7·9).

7·3. *Hours of work* shall have to be fixed according to the convenience of the different sections of the local population. In general, it would be better to have two shifts, one in the morning and the other in the evening.

7·4. *Working arrangements.*—It is important to make proper arrangement for work so that the persons who come for *x*-ray do not have to wait for long or are not crowded together at any one phase of the work.

7·5. When a person comes with the token for *x*-ray his identity has to be checked, the relevant *x*-ray card taken out and the *x*-ray No. stamped on the card and on the main copy of the Schedule. It is preferable to engage three persons for this work. The duties of the first and second clerks will, however, differ according to the type of token used (see para 5·22).

7·5·1. When Household Schedule is used as token.

7-5·1·1. The first clerk will check the identity of the person by referring to the particulars given against his name in the token (Household Schedule). If he is satisfied he will call out the 'ref. no.' of the person (see para 6·1) to the second clerk sitting by his side. If he doubts the identity of the person he will ask him to wait and inform the team leader about it. The first clerk will then put his initials in the token (Schedule) against the names of persons who have come for *x*-ray and also keep a note of persons whom he has asked to wait for further identification.

7·5·1·2. If all persons to be *x*-rayed from a particular household have not come for *x*-ray the first clerk will return the token (Schedule) to the last person from the

household who has come for *x*-ray and will instruct him to send the remaining members of the household for *x*-ray.

7·5·1·3. The second clerk will have with him the bundle of cards for the area, arranged according to 'ref. no.' (see para 6·1). When the first clerk calls out a 'ref. no.' he will take out the relevant card, hand it over to the person and instruct him to go, with the card, to the third clerk.

7·5·2. When separate token slips are used.

7·5·2·1. The first clerk will have with him the bundle of cards for the area, arranged according to 'ref. no.' (see para 6·1). When a person comes with the token (which shows the ref. no) he will take out the relevant card and instruct the person to go with the card to the second clerk.

7·5·2·2. If some cards for the household are still left the first clerk should enquire from the person about those members of the houshold who have not come and instruct him to send them for *x*-ray.

7·5·2·3. The second clerk will check the identity of the person by referring to the particulars given on the card and if he is satisfied he will put his initials in one corner of the card and ask the person to go with the card to the third clerk.

7·6. The third clerk should be seated near the *x*-ray van and should have with him the main copy of the Household Schedules and the duplicate numbering machine. When a person comes with an *x*-ray card he will put the *x*-ray No. on the *x*-ray card as well as in the relevant row of col. 11 of the Schedule. He will also put the date on the *x*-ray card and ask the person to go, with the card, to the *x*-ray van. Whether a person has been *x*-rayed or not should be stated in all cases by this clerk by entering 'yes' or 'no' as the case may be in col. 10.

Note : If different numbering machines are used for stamping numbers on the card and on the Schedule, the numbers on the machines should be compared frequently (say after every 50 numbers).

7·7. If an *x*-ray number has been stamped on a card and if for any reason the individual was not *x*-rayed the *x*-ray technician should note this fact clearly on the *x*-ray card and also inform the third clerk to make similar entries in the schedule. In order to clearly indicate that *x*-ray was not taken for that number and that it was no omission due to technical defects any suitable object at hand may be photographed on that film. Every effort should, however, be made to keep such wastage to barest minimum.

7·8. At the end of each sitting compare the number of camera exposures with the difference in numbers on the stamping machine at the end of this and the previous sittings. Any disparity should be accounted for.

7·9. In general, till a fairly large fraction (about 75 per cent) of the population to be *x*-rayed is covered, people should be persuaded to come for *x*-ray by general approach. After that a list of non-respondents should be prepared on the basis of the *x*-ray cards left and each non-respondent should be persuaded through

personal contact to come for *x*-ray. Whenever necessary, the help of influential people of the locality should be sought.

7·10. If, inspite of best efforts, it has not been possible to *x*-ray some persons the reasons for the same should be entered in the card as well as in cols. 10 and 11 of the main copy of the Schedule. The medical officer in charge of the field work should also give report about the general state of health of each non-respondent who is present in the village or block at the time of the survey.

B. READING OF *X*-RAY FILMS

8. General Procedure

8·1. The developing of the 70 mm. *x*-ray films should be done as soon as possible. If darkroom and cooling facilities for developing are available in the mobile *x*-ray unit itself, the films may be developed at the end of the day's work. Otherwise, the exposed rolls should be sent to headquarters once or twice a week depending upon the number of film rolls taken and the distance to headquarters.

8·2. Reading of the films should preferably be done independently by two readers. If the films are developed in the field and a doctor trained for reading miniature films is travelling with the unit, the first reading may be done on the spot ; otherwise, the readings will be done at headquarters. If duplicate readings can be done within few days, the list of cases selected for bacteriological examination should be prepared on basis of both readers' reading. Every case showing pathology whether found by both or by only one of the two readers should be submitted to bacteriological examination. If there is delay in obtaining the second reading, the instructions given by the first reader should be carried out as soon as possible.

8·3. When reading the films the reader should dictate his findings to a clerk without himself referring to the individual cards. This is to ensure an unbiased reading. The same procedure should be followed by the second reader who should study the films without knowing the findings of the first reader.

The entries, X, Y, Z and on the cards stand for different readers, X & Y indicating first and second within each zone, and Z a reader from the centre.

8·4. Care should be taken to see that the correct cards are entered, *e.g.* by the reader calling out the film No. and the clerk answering with the name of the person photographed which, of course, must tally with the name shown on the *x* ray picture.

9. *X*-ray code.

9.1. The Code contains the following four headings :—

I. Type of Pathology.
II. Cavity.
III. Impressions regarding Aetiology.
IV. Calcifications.

The first two groups allow an objective, descriptive recording of the pathological findings without any consideration of the nature of the pathology. Group IV—Calcifications—records merely absence or presence of calcifications, also without considering possible aetiology. Group III—Impressions regarding aetiology—enables the reader to classify the cases according to whether he thinks they are tuberculous or not. This classification must necessarily be very subjective.

9·2. *If pathology is present, an entry should be made under all four headings.* Exceptions from this rule are :

(*i*) Calcifications without any other visible pathology, when IV.2 is ticked off leaving groups I—III unmarked.

(*ii*) Cardio-vascular pathology without any lesions in the lung fields, when 1·13 only need be marked.

9·3. If more than one type of pathology is found, the *main lesion should be noted.* Examples : If there are a parenchymal lesion as well as exudative pleurisy the former should be noted, or if a pneumonic process plus a fibrotic scar are seen, the former should be noted and the latter ignored.

9·4. While offering some explanatory remarks regarding the various headings and sub-headings of the *x*-ray code, it is not the intention to give a complete and exhaustive list of all possible findings in an *x*-ray picture and their classification but the remarks are intended to serve merely as a general guide. In order to obtain as uniform reading as possible between different readers co-operating in the Survey, arrangements will be made for readers to come together and study films simultaneously, as well as for duplicate or triplicate readings of films from various zones by senior readers.

9·5. Group I. *Type of Pathology.*—Notes on sub-groups :

I·1. '*Minimal parenchymal lesions*'—Small, single foci or just a few tiny nodules ; or an isolated soft shadow not larger than one square centimeter or the width of the posterior end of a rib.

I·2. '*Moderate parenchymal lesions*'.—Pathological changes varying from a few foci or infiltrations to lesions involving up to 2/3 of one lobe, or an equal quantity of lesions scattered through two or more lobes ; this is regardless of whether cavities are present or not.

I·3. '*Extensive parenchymal lesions*'.—(*i*) Lesions involving the greater part of one lobe, *i.e.* at least 2/3 or 3/4 of the lobe, or more. (*ii*) lesions in two lobes or more which in extent would correspond to that mentioned under (*i*); and (*iii*) generalized spread over all lung fields of small patches or circumscript foci as seen in cases of miliary tuberculosis, extensive bronchogenic spread, carcinomatosis etc.

I·4. '*Lobar Pneumonia*'.—Solid pneumonia involving the whole of one or more lobes.

I·5. '*Atelectasis*'.—Complete atelectasis of one or more lobes. Small areas of atelectasis or segmental atelectasis should be entered under 1·2 or 1·3.

1·6. *'Fibrotic scar in lung'*.—Isolated fibrotic strands or bands in the lung parenchyma without any other pathological changes being present.

1·7. *'Hilar adenitis'*.—Solid or dense shadows with founded contours in the hilar regions suggestive of enlarged lymph nodes. Exaggerated vascular shadows of the hilum should not be noted. Ferihilar parenchymal lesions should be entered under 1·2 or 1·3.

1·8. *'Pleural scar'*—Obliterated costo-phrenic angles or thickened pleura.

1·9. *'Pleural effusion'*—Shadows filling up the costo-phrenic angle but not exceeding the level of the dome of the diaphragm.

1·10. *'Pleural effusion, moderate or extensive'* : Effusions of greater extent than mentioned under 1·9

1·11. *'Hydropneumothorax/pneumothorax'* : (*i*) Pneumothorax with partial collapse of the lung where the lung itself shows no definite involvement, otherwise enter under 1·2. or 1·3. ; (*ii*) complete collapse of the lung by pneumothorax where the condition of the lung cannot be ascertained ; (*iii*) cases of pneumoperitoneum with no obvious pulmonary involvement (otherwise enter under 1·2 or 1·3)

1·12. *'Cardio-vascular pathology'*—Marked alteration of shape or/and size of heart or aorta (or bovinum, mitral, or aortic stenosis, aneurysm aortae etc.), also cases of congestion to the lungs.

1·13. *'Operated (thoracoplasty, resection etc.)'*—Operated cases where the lungs show no definite involvement ; otherwise mark under 1·2 or 1·3.

1·14. *'Special pathology'* tumors of lungs or mediastinum, hydatid cysts, or any other peculiar condition which do not readily come under any of the categories mentioned above ; details may be entered briefly under 'Remarks'.

1·15. *'Technical error'*—All pictures which cannot be interpreted with reasonable certainty due to technical error such as shaking of the person false light, marked under or overexposure, double exposures, part of the lung fields cut off, dirty films, spots, scratches etc.

Under 'Remarks' can be entered anything of interest such as situs inversus (true dextrocardia), marked maldeformity of chest or spine, or anything concerning entries.

9·6. Group II--*CAVITY*.—In every case with lung pathology present an entry must be made under this heading. All shadows suggestive of cavities, irrespective of their aetiology, size and number, should be noted under either 'Doubtful' or 'Present'.

9·7. Group III—*IMPRESSIONS Regarding AETIOLOGY*.—All cases thought to be of non-tuberculous nature should be marked under 'A', those which appear to be of tuberculous origin under 'B', 'C' or 'D', and doubtful cases under 'E'

III. A : Cases of suspected lung abscess, non-tuberculous pneumonia, bronchiectasis, congestion, tumors, hydatid cysts, cystic lung, or any other non-tuberculous condition.

III. B : Cases probably due to tuberculosis but which are not likely to excrete any bacilli

III. C : Cases of tuberculous nature which may or may not excrete bacilli.

III. D : Cases which most probably excrete tubercle bacilli.

III. E ; Atypical cases or such cases which could equally well be caused by tuberculosis or by some other diseases ; in short, such cases where the reader would refrain from committing himself to any special aetiology.

9·8. Group IV --*CALCIFICATIONS.*—Definite calcified foci in the lung parenchyma or pleura, irrespective of whether any other pathology is present or not. Care should be taken not to be misled by blood vessels photographed end on end, especially in the hilar regions, or any artifacts such as buttons or things in pockets or clothes.

C. BACTERIOLOGICAL EXAMINATION.

10·1. *All cases showing lung pathology on x-ray should be submitted to bacteriological examination for tubercle bacilli.* The only exceptions are cases with calcifications only or with mere scars in the pleura of lungs.

10·2. The *x*-ray reader must clearly note on the individual cards that bacteriological examination is wanted. After each session of *x*-ray readings all cards thus marked should be collected and handed over to the pathologist responsible for this part of the survey. A list should be prepared of all persons wanted for bacteriology. The pathologist will arrange for the collection of specimens as soon as possible.

10·3. The bacteriological examination should follow as soon as possible after the *x*-ray photograph has been taken. If the films are developed on the spot and the *x*-ray reading done in the field, it may be possible to have the bacteriological examination done within a few days after taking the films. However, in most centres the two procedures, the photographing and the bacteriological examination, will be separated functions, and the latter will follow within a week or two after the former. The pathologist should have his own staff and transport so that the bacteriological team can move into the field at their own convenience.

10·4. All necessary equipment and staff for the bacteriological examination can be contained in a Willys Jeep station wagon, including furniture such as folding chairs, campcots, portable kerosene refrigerator, cases with culture bottles, oxalic acid, sodium citrate, water, etc. A list of the equipment is given in Section 10·9 of this Appendix.

10·5. A list of persons to be examined and instructions about time and venue should be sent in advance to the district health officer, the local sanitary inspector, the village karnam or any other authority who will be responsible for informing the people concerned where and when to meet.

10·6. If it is possible to secure a centrally located house, room or at least a verandah it will be most convenient and time-saving to set up a temporary office there where people could come, instead of going from house to house to round up the persons to be examined. The inoculation of the culture bottles with laryngeal swabs is best done indoors after each session so that contamination may be reduced to a minimum.

10·7. The bacteriological investigation is based upon collection of (*i*) 2 laryngeal swab cultures; and if sputum is available, (*ii*) 2 direct smears for microscopy and (*iii*) 2 sputum swab cultures. This is considered the basic minimum. If the laboratory at zonal headquarters is equipped for the same, it would be valuable if also (*iv*) a culture of the sputum could be made after homogenization.

10·8. The procedure to be followed at the temporary centre in the field may be as follows :—

1. Keep a register of persons to be examined and their *x*-ray cards arranged in the same order.
2. Check patient's number and name and other points of identification.
3. Take 2 laryngeal swabs and place these in a test tube and cover it so that they are not exposed to light while other swabs are being taken.
4. Immediately after the laryngeal swabs have been taken, encourage the person to try to produce sputum and spit into a sputum cup—paraffined pill box or bottle; the bottle should be covered to avoid exposure to light.
5. At the field centre, culture the laryngeal swabs and also the sputum by the sputum swab method, two swabs each.
   (*i*) Pour 5 per cent Oxalic Acid (previously sterilized) into the tubes containing either laryngeal or sputum swabs to cover the cotton wool portion and leave for 10 minutes.
   (*ii*) Pour off the Oxalic Acid and pour in 5 per cent Sodium Citrate and leave for 10 minutes.
   (*iii*) Gently press the swabs on the side of the test tube to get rid of excess reagent and then rub on the Lowenstein-Jensen medium, one swab to each tube.
   (*iv*) Keep the culture medium at ordinary temperature until return to the central laboratory.
6. Make 2 slides, using new slides, from the sputum. These can be fixed immediately, but staining and examining can be done in the central laboratory. The number is written on the slide with a diamond pencil. The slides are to be kept for future reference if required.
7. If a small kerosene oil refrigerator is available, cost (Rs. 700 approximately) the sputum should be kept in the refrigerator and on return to the central laboratory it can be dealt with by the ordinary homogenization method, *e.g.* equal quantity of 6 per cent (Vol.) sulphuric acid for 15 minutes followed by centrifuging for 15 minutes ; the sediment is washed with sterile water and recentrifuged. Culture on Lowenstein-Jensen medium.
8. Report on cultures, discarding them after 6 weeks. Positive cultures should be kept, in case investigation of sputum is required later.

Material Required by Laboratory team

10·9. Sterile laryngeal swab—2 per person ; sterile test tubes—1 for 2 laryngeal swabs ; sputum culture bottle—McCartney bottles covered with dark paper—1 per person ; 1 pair of forecps for straightening swab ; 1 spirit lamp ; 4 boxes of matches ; 2 bottles of 200 c.c. sterile 5 per cent oxalic acid ; 2 bottles of 200 c.c. sterile 5 per cent sodium citrate ; 2 bottles of 200 c.c. sterile distilled water ; 4 bottles culture media Lowenstein—Jensen per person ; glass pencil ; ordinary pencil and pen ; diamond pencil ; microscope slides ; swab for sputum culture ; Face masks and gown ; toilet paper for holding tongue ; few extra bottles, wide mouthed ; grass sticks for making sputum smears ; note book ; Bowl and lotion ; bucket ; test-tube racks ; table and chairs ;

APPENDIX 2.

Estimates and Errors

As the survey was done by sampling, the estimation of the prevalence rates and their standard errors required the application of certain statistical formulae. The method of sampling was different in cities, towns and villages and consequently the formulae applied also differed for these three areas. The general formulae applied can be seen from the following illustration ;

If,

R be the number of strata in the zone,

M_i the total number of towns in the i^{th} stratum,

m_i the number of towns from the i^{th} stratum included in the sample,

N_{ij} the number of blocks in the j^{th} town from the i^{th} stratum,

n_{ij} the number of blocks from the j^{th} town in the i^{th} stratum included in the sample,

X_{ijk} the number of persons with tuberculosis in the k^{th} block of the j^{th} town in the i^{th} stratum,

and Y_{ijk} the number of persons in the k^{th} block of the j^{th} town of the i^{th} stratum,

then the estimate X of the total number of tuberculosis cases in the R strata is given by

$$X=\sum_{i=1}^{R}\left(\frac{M_i}{m_i}\right)\sum_{j=1}^{m_i}\left(\frac{N_{ij}}{n_{ij}}\right)\sum_{k=1}^{n_{ij}}X_{ijk} \qquad \cdots \qquad (1)$$

Similarly the total number of persons in the R strata will be given by

$$Y=\sum_{i=1}^{R}\left(\frac{M_i}{m_i}\right)\sum_{j=1}^{m_i}\left(\frac{N_{ij}}{n_{ij}}\right)\sum_{k=1}^{n_{ij}}Y_{ijk} \qquad \cdots \qquad (2)$$

The prevalence rate is estimated by $\frac{X}{Y}\times 1000$.

The variances of X and Y and their covariance are approximately given by

$$V(X)=\sum_{i=1}^{R}\frac{M_i^2}{m_i^2}\cdot\frac{m_i}{m_i-1}\,\text{Exp.}\sum_{j=1}^{m_i}(X'_{ij}-\overline{X'}_i)^2 \qquad \cdots \qquad (3)$$

$$V(Y)=\sum_{i=1}^{R}\frac{M_i^2}{m_i^2}\cdot\frac{m_i}{m_i-1}\,\text{Exp.}\sum_{j=1}^{m_i}(Y'_{ij}-\overline{Y'})^2 \qquad \cdots \qquad (4)$$

$$\text{and Cov. } (XY) = \sum_{i=1}^{R} \frac{M_i^2}{m_i^2} \cdot \frac{m_i}{m_i - 1} \text{ Exp. } \sum_{j=1}^{m_i} (X'_{ij} - \bar{X}'_i)(Y'_{ij} - \bar{Y}'_i) \quad \ldots \quad (5)$$

$$\text{where } X'_{ij} = \frac{N_{ij}}{n_{ij}} \sum_{k=1}^{n_{ij}} X_{ijk} \; ; \; \bar{X}'_i = \frac{1}{m_i} \sum_{j=1}^{m_i} X'_{ij}$$

$$\text{and } Y'_{ij} = \frac{N_{ij}}{n_{ij}} \sum_{k=1}^{n_{ij}} Y_{ijk} \; ; \; \bar{Y}'_i = \frac{1}{m_i} \sum_{j=1}^{m_i} Y'_{ij} .$$

The variance of X/Y is then approximately given by

$$V\left(\frac{X}{Y}\right) = \frac{Y^2 V(X) + X^2 V(Y) - 2XY \text{ Cov. } (XY)}{Y^4} \quad \ldots \quad (6)$$

and its coefficient of variation by

$$\text{Cov. } \left(\frac{X}{Y}\right) = \sqrt{\left\{ \frac{V(X)}{X^2} + \frac{V(Y)}{Y^2} - 2 \frac{\text{Cov. } (XY)}{XY} \right\}} \quad \ldots \quad (7)$$

In practice the value of $Xijk$, the number of tuberculosis cases in each village or block was itself the result of a calculation based on the survey findings as discussed in Chapter IV of the report.

The formulæ given above are directly applicable in estimating the prevalence rates for towns within each zone and their standard errors. For villages the sampling was done by initially stratifying the villages according to size and then choosing a constant proportion of the villages from each stratum. In cities, except in Delhi, a certain number of blocks was selected at random without any stratification. In Delhi the blocks were grouped into three strata, New Delhi, Old Delhi and suburbs, and from each stratum the same proportion of blocks was selected for survey. The formulæ given above had to be correspondingly altered to be applicable for villages and cities.

Applying formula (7) above to the data for individual blocks and villages given in Appendix 4 the coefficients of variation have been calculated for the first index *viz.*, active and probably active cases per 1000 population, for the different cross-sections of the population in each zone. These are given in the table below :—

Coefficients of variation of estimated rates for active and probably active cases

Zone	City	Towns	Villages
Calcutta	9·7	*	*
Delhi	7·7	25·1	6·3
Hyderabad	13·2	16·4	10·2
Madanapalle	4·0	7·0	6·4
Patna	6·5	14·2	5·7
Trivandrum	4·4	11·0	7·7

*Survey not completed.

Appendix 3

Table I.—*Reasons for non-response to x-ray.*

Area	Sex	Eligible for x-ray	Not x-rayed because								Total	
			Refused		Physical inability		Out of home		Other reasons			
			No.	per cent.	No.	per cent.	No.	per cent.	No.	per cent.	No.	per cent.
I. Calcutta Zone.												
City	Males	11,752	113	1·0	66	0·6	945	8·0	578	4·9	1,702	14·5
	Females	6,955	158	2·3	134	1·9	297	4·3	261	3·8	850	12·2
	Total	**18,707**	**271**	**1·4**	**200**	**1·1**	**1,242**	**6·6**	**839**	**4·5**	**2,552**	**13·6**
II. Delhi Zone.												
City	Males	13,853	146	1·1	35	0·2	916	6·6	11	0·1	1,108	8·0
	Females	10,853	108	1·0	68	0·6	641	5·9	1	0·0	818	7·5
	Total	**24.706**	**254**	**1·0**	**103**	**0·4**	**1,557**	**6·3**	**12**	**0·0**	**1,926**	**7·8**
Towns	Males	6,344	26	0·4	10	0·2	327	5·2	1	0·0	364	5·7
	Females	5,663	22	0·4	33	0·6	373	6·6	—	0·0	428	7·6
	Total	**12,007**	**48**	**0·4**	**43**	**0·4**	**700**	**5·8**	**1**	**0·0**	**792**	**6·6**
Villages	Males	13,955	6	0·0	14	0·1	468	3·4	7	0·0	495	3·5
	Females	12,513	1	0·0	45	0·4	849	6·8	3	0·0	898	7·2
	Total	**26,468**	**7**	**0·0**	**59**	**0·2**	**1,317**	**5·0**	**10**	**0·0**	**1,393**	**5·3**

APPENDIX 3

TABLE I.—*Reasons for non-response to x-ray (Contd.)*

III—Hyderabad Zone.

Area	Sex	Eligible for x-ray	Not x-rayed because								Total	
			Refused		Physical Inability		Out of home		Other reasons			
			No.	per cent.	No.	per cent.	No.	per cent.	No.	per cent.	No.	per cent.
City	Males	16,156	133	0·8	50	0·3	1,093	6·8	—	—	1,276	7·9
	Females	15,500	268	1·7	174	1·1	698	4·5	—	—	1,140	7·4
	Total	**31,656**	**401**	**1·3**	**224**	**0·7**	**1,791**	**5·7**	—	—	**2,416**	**7·6**
Towns	Males	3,050	15	0·5	4	0·1	246	8·1	—	—	265	8·7
	Females	2,762	75	2·7	19	0·7	72	2·6	—	—	166	6·0
	Total	**5,812**	**90**	**1·6**	**23**	**0·4**	**318**	**5·5**	—	—	**431**	**7·4**
Villages	Males	13,764	10	0·1	68	0·5	621	4·5	—	—	699	5·1
	Females	13,297	37	0·3	194	1·5	541	4·1	—	—	772	5·8
	Total	**27,061**	**47**	**0·2**	**262**	**1·0**	**1,162**	**4·3**	—	—	**1,471**	**5·4**

APPENDIX 3

TABLE 1.—*Reasons for non-response to X-ray (Contd.)*

IV—Madanapalle Zone

		Eligible for x-ray	Not x-rayed because									
			Refused		Physical inability		Out of home		Other reasons		Total	
			No.	per cent.	No.	per cent.	No.	per cent.	No.	per cent.	No.	per cent.
City	Males	9,455	290	3·1	53	0·6	718	7·6	57	0·6	1,118	11·8
	Females	8,416	206	2·4	113	1·3	410	4·9	38	0·5	767	9·1
	Total	**17,871**	**496**	**2·8**	**166**	**0·9**	**1,128**	**6·3**	**95**	**0·5**	**1,885**	**10·5**
Towns	Males	7,351	30	0·4	22	0·3	544	7·4	33	0·4	629	8·6
	Females	6,805	32	0·5	95	1·4	436	6·4	9	0·1	572	8·4
	Total	**14,156**	**62**	**0·4**	**117**	**0·8**	**980**	**6·9**	**42**	**0·3**	**1,201**	**8·5**
Villages	Males	11,222	31	0·2	52	0·5	830	7·4	137	1·2	1,050	9·4
	Females	10,497	44	0·4	177	1·7	719	6·8	107	1·0	1,047	10·0
	Total	**21,719**	**75**	**0·3**	**229**	**1·1**	**1,549**	**7·1**	**244**	**1·1**	**2,097**	**9·7**

APPENDIX 3

TABLE 1.—*Reasons for non-response to x-ray (Contd.)*

V—Patna Zone

Area	Sex	Eligible for x-ray	Not x-rayed because								Total	
			Refused		Physical inability		Out of home		Other reasons			
			No.	per cent.	No.	per cent.	No.	per cent.	No.	per cent.	No.	per cent.
City	Males	9,133	299	3·3	124	1·4	564	6·2	11	0·1	998	10·9
	Females	7,537	209	2·8	197	2·6	286	3·8	10	0·1	702	9·3
	Total	**16,670**	**508**	**3·0**	**321**	**1·9**	**850**	**5·1**	**21**	**0·1**	**1,700**	**10·2**
Towns	Males	6,870	572	8·3	114	1·7	619	9·0	—	—	1,305	19·0
	Females	5,372	527	9·8	172	3·2	358	6·7	—	—	1,057	19·7
	Total	**12,242**	**1,099**	**9·0**	**286**	**2·3**	**977**	**8·0**	—	—	**2,362**	**19·3**
Villages	Males	7,685	79	1·0	22	0·3	129	1·7	—	—	230	3·0
	Females	6,683	145	2·2	66	1·0	107	1·6	—	—	318	4·8
	Total	**14,368**	**224**	**1·6**	**88**	**0·6**	**236**	**1·6**	—	—	**548**	**3·8**

APPENDIX 3

TABLE 1—*Reasons for non-response to x-ray (Concld.)*

VI—Trivandrum Zone

Area	Sex	Eligible for x-ray	Not x-rayed because								Total	
			Refused		Physical inability		Out of home		Other reasons			
			No.	per cent.	No.	per cent.	No.	per cent.	No.	per cent.	No.	per cent.
City	Males	10,720	1,611	15·0	44	0·4	1,215	11·3	—	—	2,870	26·8
	Females	10,989	1,881	17·1	85	0·8	207	1·9	1	0·0	2,174	19·8
	Total	**21,709**	**3,492**	**16·1**	**129**	**0·6**	**1,422**	**6·6**	**1**	**0·0**	**5,044**	**23·2**
Towns	Males	5,167	520	10·1	61	1·2	761	14·7	5	0·1	1,347	26·1
	Females	5,135	974	19·0	147	2·9	239	4·6	—	—	1,360	26·5
	Total	**10,302**	**1,494**	**14·5**	**208**	**2·0**	**1,000**	**9·7**	**5**	**0·0**	**2,707**	**26·3**
Villages	Males	23,714	1,566	6·6	234	1·0	2,502	10·6	7	0·0	4,309	18·2
	Females	23,941	2,651	11·1	557	2·3	1,328	5·5	10	0·0	4,546	19·0
	Total	**47,655**	**4,217**	**8·8**	**791**	**1·7**	**3,830**	**8·0**	**17**	**0·0**	**8,855**	**18·6**

APPENDIX 3

TABLE II—*Non-response to x-ray by age and sex.*

I—Calcutta Zone.

Age and sex group	Eligible for x-ray	Not x-rayed	Percentage
City			
Males			
5-14	2,458	163	6·6
15-24	3,168	358	11·3
25-34	2,634	439	16·
35-44	1,621	336	20·7
45-54	990	235	23·7
55 and above	881	171	19·4
Total	**11,752**	**1,702**	**14·5**
Females			
5-14	1,995	140	7·0
15-24	1,623	208	12·8
25-34	1,417	207	14·6
35-44	841	121	14·4
45-54	522	67	12·8
55 and above	557	107	19·2
Total	**6,955**	**850**	**12·2**
Grand total	**18,707**	**2,552**	**13·6**

TABLE II—*Non-response to x-ray by age and sex. (contd.)*

II—Delhi Zone.

Age and sex groups	City			Towns			Villages		
	Eligible for x-ray	Not x-rayed	Percentage	Eligible for x-ray	Not x-rayed	Percentage	Eligible for x-ray	Not x-rayed	Percentage
Males									
5-14	3,194	179	5·6	2,043	83	4·1	4,387	117	2·7
15-24	3,141	256	8·2	1,408	88	6·3	2,701	111	4·1
25-34	3,511	306	8·7	1,070	85	7·9	2,072	102	4·9
35-44	2,043	178	8·7	730	35	4·8	1,872	77	4·1
45-54	1,118	108	9·7	621	36	5·8	1,298	43	3·3
55 and above	846	81	9·6	472	37	7·8	1,625	45	2·8
Total	**13,853**	**1,108**	**8·0**	**6,344**	**364**	**5·7**	**13,955**	**495**	**3·5**
Females									
5-14	2,850	190	6·7	1,733	88	5·1	3,513	173	4·9
15-24	2,829	229	8·1	1,255	175	13·9	2,995	400	13·4
25-34	2,467	177	7·2	949	69	7·3	2,206	176	8·0
35-44	1,159	94	8·1	694	34	4·9	1,612	77	4·8
45-54	802	57	7·1	489	29	5·9	1,154	34	2·9
55 and above.	746	71	9·5	543	33	6·1	1,033	38	3·7
Total	**10,853**	**818**	**7·5**	**5,663**	**428**	**7·6**	**12,513**	**898**	**7·2**
Grand Total	**24,706**	**1,926**	**7·8**	**12,007**	**792**	**6·6**	**26,468**	**1,393**	**5·3**

APPENDIX 3

TABLE II—*Non-response to x-ray by age and sex (contd.)*

III—Hyderabad Zone

Age and sex group	City			Towns			Villages		
	Eligible for x-ray	Not x-rayed	Percentage	Eligible for x-ray	Not x-rayed	Percentage	Eligible for x-ray	Not x-rayed	Percentage
Males									
5-14	5,294	169	3·2	912	16	1·8	3,947	107	2·7
15-24	3,471	266	7·7	770	52	6·8	2,390	140	5·8
25-34	2,870	315	10·9	546	82	15·0	2,656	146	5·5
35-44	2,005	240	11·9	391	56	14·3	1,997	122	6·1
45-54	1,357	157	11·6	241	36	14·9	1,595	80	5·0
55 and above	1,159	129	11·1	190	23	12·1	1,179	104	1·2
Total	**16,156**	**1,276**	**7·9**	**3,050**	**265**	**8·7**	**13,764**	**699**	**5·1**
Females									
5-14	4,769	144	3·0	713	12	1·7	4,041	136	3·4
15-24	3,559	339	9·5	604	41	6·8	2,442	187	7·6
25-34	2,443	263	8·9	651	58	8·9	2,589	144	5·6
35-44	1,793	138	7·7	357	31	8·7	1,618	83	5·1
45-54	1,263	113	8·9	264	14	5·3	1,539	89	5·5
55 and above	1,173	143	12·2	173	10	5·8	1,068	133	12·2
Total	**15,500**	**1,140**	**7·4**	**2,762**	**166**	**6·0**	**13,297**	**772**	**5·8**
Grand Total	**31,656**	**2,416**	**7·6**	**5,812**	**431**	**7·4**	**27,061**	**1,471**	**5·4**

TABLE II—*Non-response by age and sex (contd.)*

IV—Madanapalle Zone

Age and sex groups	City			Towns			Villages		
	Eligible for x-ray	Not x-rayed	Percentage	Eligible for x-ray	Not x-rayed	Percentage	Eligible for x-ray	Not x-rayed	Percentage
Males									
5-14	2,866	159	5·5	1,966	96	4·9	3,261	222	6·8
15-24	1,952	243	12·4	1,524	172	11·3	2,143	248	11·6
25-34	1,734	250	14·4	1,383	137	9·9	1,815	187	10·3
35-44	1,416	203	14·3	1,119	90	8·0	1,671	184	11·0
45-54	845	142	16·8	752	62	8·2	1,192	96	8·0
55 and above	642	121	18·8	607	72	11·9	1,140	113	9·9
Total	**9,455**	**1,118**	**11·8**	**7,351**	**629**	**8·6**	**11,222**	**1,050**	**9·4**
Females									
5-14	2,576	157	6·1	2,015	124	6·2	3,162	224	7·1
15-24	1,948	186	9·5	1,409	152	10·8	1,901	310	16·3
25-34	1,698	139	8·2	1,372	102	7·4	2,005	158	7·9
35-44	974	77	7·9	843	54	6·4	1,483	102	6·9
45-54	656	80	12·2	638	61	9·6	1,045	96	9·2
55 and above	564	128	22·7	528	79	15·0	901	157	17·4
Total	**8,416**	**767**	**9·1**	**6,805**	**572**	**8·4**	**10,497**	**1,047**	**10·0**
Grand Total	**17,871**	**1,885**	**10·5**	**14,156**	**1,201**	**8·5**	**21,719**	**2,097**	**9·6**

APPENDIX 3

TABLE II—*Non-response to x-ray by age and sex.* (*contd.*)

V—Patna Zone.

Age and sex groups	City			Towns			Villages		
	Eligible for *x*-ray	Not *x*-rayed	Percentage	Eligible for *x*-ray	Not *x*-rayed	Percentage	Eligible for *x*-ray	Not *x*-rayed	Percentage
Males									
5-14	2,665	90	3·4	1,987	207	10·4	2,495	45	1·8
15-24	2,041	211	10·3	1,419	259	18·2	1,352	47	3·5
25-34	1,691	216	12·8	1,332	282	21·2	1,398	43	3·1
35-44	1,307	192	14·7	951	236	24·8	1,087	37	3·4
45-54	824	139	16·9	693	188	27·1	726	26	3·6
55 and above	605	150	24·8	488	133	27·2	627	32	5·1
Total	**9,133**	**998**	**10·9**	**6,870**	**1,305**	**19.0**	**7,685**	**230**	**3·0**
Females									
5-14	2,099	119	5·7	1,729	238	13·8	1,960	60	3·1
15-24	1,731	211	12·2	1,078	258	23·9	1,185	85	7·2
25-34	1,544	129	8·4	942	207	22·0	1,361	61	4·5
35-44	942	67	7·1	747	127	17·0	863	38	4·4
45-54	720	70	9·7	493	103	20·9	791	31	3·9
55 and above	501	106	21·2	382	122	31·9	523	43	8·2
Total	**7,537**	**702**	**9·3**	**5,372**	**1,057**	**19·7**	**6,683**	**318**	**4·8**
Grand Total	**16,670**	**1,700**	**10·2**	**12,242**	**2,362**	**19·3**	**14,368**	**548**	**3·8**

TABLE II—*Non-response to x-ray by age and sex. (contd.)*

VI—Trivandrum Zone.

Age and sex groups	City			Towns			Villages		
	Eligible for x-ray	Not x-rayed	Percentage	Eligible for x-ray	Not x-rayed	Percentage	Eligible for x-ray	Not x-rayed	Percentage
Males									
5-14	3,421	236	6·9	1,375	210	15·3	7,146	806	11·3
15-24	2,252	667	29·6	1,150	310	27·0	4,942	987	20·0
25-34	1,930	775	40·2	983	288	29·3	4,091	871	21·3
35-44	1,240	545	44·0	686	226	32·9	3,129	664	21·2
45-54	1,035	350	33·8	480	160	33·3	2,312	482	20·8
55 and above	842	297	35·3	493	153	31·0	2,094	499	23·8
Total	**10,720**	**2,870**	**26·8**	**5,167**	**1,347**	**26·1**	**23,714**	**4,309**	**18·2**
Females									
5-14	3,425	345	10·1	1,448	268	18·5	7,490	915	12·2
15-24	2,453	558	22·7	1,083	348	32·1	5,161	1,306	25·3
25-34	1,850	435	23·5	919	239	26·0	4,491	811	18·1
35-44	1,316	281	21·4	760	170	22·4	2,852	462	16·2
45-54	1,008	248	24·6	410	125	30·5	1,935	350	18·1
55 and above	937	307	32·8	515	210	40·8	2,012	702	34·9
Total	**10,989**	**2,174**	**19·8**	**5,135**	**1,360**	**26·5**	**23,941**	**4,546**	**19·0**
Grand Total	**21,709**	**5,044**	**23·2**	**10,302**	**2,707**	**26·3**	**47,655**	**8,855**	**18·6**

APPENDIX 4

Block and village-wise data for 'active' and 'probably active' cases.

I—Calcutta zone

City

Block No.	Number *x*-rayed.	Active and probably active cases	
		Estimated number	Rate per 1000
1.	485	4·419	9·11
2.	480	1·805	3·76
3.	175	0·614	3·51
4.	310	2·209	7·13
5.	480	5·919	12·33
6.	690	5·686	8·24
7.	530	9·994	18·86
8.	335	16·884	50·40
9.	680	19·009	29·43
10.	505	13·753	27·24
11.	490	8·203	16·74
12.	465	9·658	20·77
13.	1,155	21·464	17·72
14.	435	6·776	15·58
15.	535	7·212	13·48
16.	275	2·996	10·90
17.	255	2·406	9·44
18.	225	4·303	19·12
19.	740	10·696	14·46
20.	510	10·416	20·43
21.	340	3·787	11·14
22.	340	1·841	5·42
23.	335	12·299	36·72
24.	775	10·848	14·00
25.	270	4·628	17·14
26.	120	1·362	11·36
27.	195	1·228	6·30
28.	120	1·496	12·48
29.	10	—	00·00
30.	595	9·860	16·57
31.	255	4·363	17·11
32.	285	3·826	13·42
33.	385	1·787	4·64
34.	210	0·519	2·48
35.	545	6·151	11·29
36.	290	3·293	11·36
37.	150	1·695	11·30
38.	425	8·133	19·14
39.	350	20·343	58·12
40.	405	8·440	20·84

APPENDIX 4

Block and village-wise data for 'active' and probably active' cases (contd.)

II—Delhi Zone

Block or village No.	Number x-rayed	Active and probably active cases	
		Estimated Number	Rate per 1000
CITY—Stratum (*Delhi*)			
1.	680	11·262	16·56
2.	495	4·379	8·85
3.	900	19·486	21·65
4.	630	18·290	29·03
5.	980	22·930	23·40
6.	395	12·753	32·29
7.	865	8·177	9·45
8.	650	16·924	26·04
9.	630	3·403	5·40
10.	665	5·799	8·72
11.	695	9·511	13·68
12.	650	5·746	8·84
13.	545	16·574	30·41
14.	1,005	48·763	48·52
15.	655	9·210	14·06
16.	640	9·259	14·47
17.	720	14·180	19·69
18.	975	23·259	23·85
19.	955	18·015	18·86
CITY—Stratum II (*New Delhi*)			
1.	1,170	15·604	13·34
2.	775	32·103	41·42
3.	710	9·876	13·91
4.	500	15·965	31·93
5.	1,335	27·497	20·60
6.	580	14·421	24·86
7.	480	14·015	29·20
8.	715	13·777	19·27
CITY—Stratum III (*Suburbs*)			
1.	725	15·091	20·81
2.	720	14·680	20·39
3.	1,340	17·427	13·01
TOWNS—Stratum I (*Population 10,000—20,000*)			
1.	375	6·379	17·01
2.	310	5·548	17·90
3.	290	1·541	5·31
4.	95	3·217	33·86
5.	250	2·392	9·57
6.	315	4·429	14·06
7.	405	6·941	17·14
8.	345	10·633	30·82
9.	500	7·487	14·97
10.	480	8·272	17·23
11.	500	6·619	13·24
12.	270	4·060	15·04
13.	285	2·950	10·35
14.	610	8·420	13·80
15.	590	7·712	13·07

APPENDIX 4

Block and village-wise data for 'active' and 'probably active' cases (concld.)

II—Delhi Zone

Block or village No.	Number x-rayed	Active and probably active cases	
		Estimated Number	Rate per 1000
TOWNS—Stratum II (*Population 20000—50000*)			
1.	1,165	6·718	5·77
2.	775	4·969	6·41
3.	440	3·337	7·58
4.	1,380	17·573	12·73
5.	295	7·281	24·68
6.	680	16·322	24·00
7.	90	0·682	7·58
8.	770	12·110	15·73
VILLAGES—Stratum I (*Population less than 500*)			
1.	200	1·424	7·12
2.	215	2·763	12·85
3.	10	0·007	0·70
4.	255	5·689	22·31
5.	300	0·885	2·95
6.	115	2·151	18·71
7.	125	2·036	16·29
8.	400	3·092	7·73
9.	355	2·668	7·52
10.	285	3·227	11·32
11.	65	1·431	22·02
12.	175	3·985	22·77
13.	340	6·216	18·28
14.	205	1·934	9·44
VILLAGES—Stratum II (*Population 500—2000*)			
1.	1,085	10·403	9·59
2.	1,060	23·311	21·99
3.	850	10·538	12·40
4.	1,680	17·434	10·38
5.	845	9·744	11·53
6.	725	11·129	15·35
7.	710	8·377	11·80
8.	820	12·710	15·50
9.	490	1·668	3·40
10.	645	4·676	7·25
11.	825	12·734	15·43
12.	735	14·003	19·05
VILLAGES—Stratum III (*Population 2000—5000*)			
1.	2,370	41·187	17·38
2.	3,335	45·974	13·79
3.	3,790	43·866	11·57
4.	2,065	33·586	16·25

APPENDIX 4

Block and village-wise data for 'active' and 'probably active' cases (contd.)

III—Hyderabad Zone.

Block or Village No.	Number x-rayed	Active and probably active cases	
		Estimated Number	Rate per 1000
	CITY		
1.	730	10·509	14·40
2.	880	4·010	4·56
3.	570	10·120	17·75
4.	635	10·185	16·04
5.	570	4·426	7·76
6.	775	15·510	20·01
7.	555	5·468	9·85
8.	835	30·856	36·95
9.	495	8·026	16·21
10.	660	26·379	39·97
11.	615	4·667	7·59
12.	950	2·994	3·15
13.	815	36·334	44·58
14.	675	17·743	26·29
15.	725	17·570	24·23
16.	670	1·858	2·77
17.	950	5·223	5·50
18.	745	33·618	45·12
19.	610	3·536	5·80
20.	700	7·753	11·08
21.	940	10·298	10·96
22.	770	10·900	14·16
23.	570	3·428	6·01
24.	610	3·176	5·21
25.	630	7·796	12·37
26.	645	3·087	4·79
27.	970	31·181	32·15
28.	605	6·199	1·02
29.	935	10·330	11·05
30.	765	8·798	11·50
31.	560	6·106	10·90
32.	550	5·149	9·36
33.	615	30·179	49·07
34.	595	11·029	18·54
35.	700	3·530	5·04
36.	520	15·045	28·93
37.	955	7·054	7·39
38.	655	5·131	7·83
39.	820	5·806	7·08
40.	820	5·857	7·14
41.	850	4·668	5·49
	TOWNS—Stratum I (*Population 10,000—20,000*)		
1.	480	13·418	27·95
2.	485	6·991	14·41
3.	470	6·396	13·61
4.	345	5·652	16·38
5.	215	3·607	16·78
6.	360	10·114	28·09
7.	245	1·679	6·85
8.	380	8·051	21·19
9.	235	2·577	10·97
10.	450	13·267	29·48
11.	280	18·101	64·65
12.	370	16·090	43·49

APPENDIX 4

Block and village-wise data for 'active' and 'probably active' cases (contd.)

III—Hyderabad Zone.

Block or Village No.	Number x-rayed	Active and probably active cases	
		Estimated Number	Rate per 1000
13.	430	6·840	15·91
14.	450	5·883	13·07
15.	390	10·360	26·56
TOWNS—Stratum II (*Population 20,000—50,000*)			
1.	360	5·528	13·36
2.	170	1·365	8·03
3.	270	3·777	13·99
4.	570	7·194	12·62
5.	470	6·610	14·06
6.	605	9·260	15·31
7.	680	8·078	11·88
8.	420	8·299	19·76
9.	560	10·016	17·89
10.	720	14·481	20·11
VILLAGES—Stratum I (*Population less than 500*)			
1.	330	7·714	23·38
2.	160	2·123	13·27
3.	170	1·012	5·95
4.	75	1·500	20·00
5.	100	1·458	14·58
6.	260	2·693	10·36
7.	160	1·028	6·43
8.	150	2·694	17·96
9.	290	6·028	20·79
VILLAGES—Stratum II (*Population 500—2,000*)			
1.	1,105	27·938	25·28
2.	520	8·925	17·16
3.	1,325	19·295	14·56
4.	1,115	17·375	15·58
5.	540	6·529	12·09
6.	615	22·506	36·60
7.	965	22·997	23·83
8.	505	11·513	22·80
9.	630	11·399	18·09
10.	840	34·902	41·55
11.	940	23·163	24·64
12.	1,080	22·126	20·49
13.	1,605	30·595	19·06
14.	625	8·686	13·90
15.	1,210	16·172	13·37
VILLAGES—Stratum III (*Population 2,000—5,000*)			
1.	1,640	19·301	11·77
2.	1,390	43·611	31·37
3.	2,210	44·842	20·29
4.	1,865	30·651	16·43
5.	1,230	20·015	16·27
6.	1,940	65·502	33·76

APPENDIX 4

Block and village-wise data for 'active' and 'probably active' cases (contd.)

IV—Madanapalle Zone

Block or village No.	Number x-rayed	Active and probably active cases		Block or village No.	Number x-rayed	Active and probably active cases	
		Estimated Number	Rate per 1000			Estimated Number	Rate per 1000
	CITY			28.	551	12·145	22·04
				29.	689	11·533	16·74
1.	375	8·083	21·55	30.	686	14·740	21·49
2.	501	10·981	21·92	31.	334	5·217	15·62
3.	325	10·079	31·01	32.	663	12·181	18·37
4.	403	6·428	15·95				
5.	740	16·194	21·88		TOWNS—Stratum I (*Population 10,000—20,000*)		
6.	825	21·709	26·31				
7.	505	9·576	18·96	1.	209	3·728	17·84
8.	293	7·226	24·66	2.	264	3·227	12·22
9.	533	13·533	25·39	3.	226	8·904	39·40
10.	545	14·905	27·35	4.	204	3·901	19·12
11.	312	4·124	13·22	5.	76	1·280	16·84
12.	388	5·055	13·08	6.	264	4·191	15·88
13.	676	14·164	20·95	7.	269	6·637	24·67
14.	153	1·814	11·86	8.	111	3·671	33·07
15.	655	11·812	18·03	9.	98	4·731	48·28
16.	335	5·097	15·21	10.	167	2·592	15·52
17.	1,123	18·648	16·61	11.	69	1·054	15·28
18.	397	7·183	18·09	12.	105	2·062	19·64
19.	520	12·632	24·29	13.	62	1·072	17·29
20.	338	5·431	16·07	14.	118	2·722	23·07
21.	525	6·192	11·79	15.	127	2·385	18·78
22.	24	0·138	5·75	16.	128	3·177	24·82
23.	507	7·577	14·94	17.	111	4·026	36·27
24.	458	11·673	25·49	18.	267	10·891	40·79
25.	540	12·798	23·70	19.	219	6·960	31·78
26.	598	9·578	16·02	20.	75	1·164	15·52
27.	469	7·332	15·63	21.	91	0·680	7·47

APPENDIX 4

Block and village-wise data for 'active' and 'probably active' cases (Contd.)

IV—Madanpalle Zone (Contd.)

Block or village No.	Number x-rayed	Active and probably active cases		Block or village No.	Number x-rayed	Active and probably active cases	
		Estimated Number	Rate per 1000			Estimated Number	Rate per 1000
22.	95	1·469	15·46	3.	185	5·873	31·75
23.	167	1·154	6·91	4.	80	3·939	49·24
24.	169	6·218	36·79	5.	98	2·041	20·83
25.	159	8·584	53·99	6.	128	1·237	9·66
26.	250	4·370	17·48	7.	153	1·546	10·10
27.	29	0·147	5·07	8.	176	3·772	21·43
28.	62	2·538	40·94	9.	134	1·969	14·69
29.	85	2·045	24·06	10.	87	2·138	24·57
30.	57	1·432	25·12	11.	133	0·225	1·69
31.	86	6·565	76·34	12.	75	0·285	3·80
32.	27	1·000	37·04	13.	146	7·370	50·48
33.	70	3·313	47·33	14.	123	2·672	21·72
34.	142	5·498	38·72	15.	321	6·143	19·14
35.	138	6·390	46·30	16.	130	1·642	12·63
36.	202	6·152	30·46	17.	105	0·997	9·50
37.	61	2·279	37·36	18.	128	2·098	16·39
38.	32	0·640	20·00	19.	168	5·016	29·86
39.	137	8·525	62·23	20.	78	1·754	22·49
40.	143	7·412	51·83	21.	161	2·668	16·57
41.	132	5·887	44·60	22.	80	1·000	12·50
42.	178	2·952	16·58	23.	80	0·147	1·84
43.	113	0·865	7·65	24.	190	1·515	7·97
44.	63	0·593	9·41	25.	152	4·448	29·26
45	54	1·132	20·96	26.	188	4·319	22·97
				27.	205	5·993	29·23
				28.	241	4·915	20·39
TOWNS—Stratum I (*Population 20,000—50,000*)				29.	145	5·668	39·09
				30.	287	6·980	24·32
1.	44	1·400	31·82	31.	257	6·141	23·89
2.	183	5·794	31·66				

32.	299	5·640	18·86
33.	134	1·150	8·58
34.	366	4·480	12·24
35.	280	9·845	35·16
36.	111	1·763	15·86
37.	288	4·646	16·13
38.	159	8·652	54·42
39.	74	0·699	9·45
40.	219	6·327	28·89
41.	251	5·753	22·92
42.	202	1·343	6·65

VILLAGES—Stratum I (*Population less than 500*)

1.	371	6·207	16·73
2.	181	3·090	17·07
3.	169	2·615	15·47
4.	111	0·709	6·39
5.	186	1·117	6·01
6.	326	6·809	20·89
7.	364	7·272	19·98
8.	405	5·057	12·40
9.	105	0·907	8·64
10.	236	6·856	29·05
11.	68	1·555	22·87
12.	144	0·439	3·05
13.	25	0·294	11·76
14.	268	3·488	13·01

VILLAGES—Stratum II (*Population 500—2000*)

1.	1,251	17·730	14·17
2.	810	28·565	35·22
3.	517	8·221	15·90
4.	987	15·918	16·13
5.	582	7·348	12·63
6.	548	7·298	13·32
7.	407	2·721	6·69
8.	436	6·173	14·16
9.	445	15·176	34·10
10.	446	8·236	18·47
11.	985	12·948	13·15
12.	604	8·177	13·54
13.	1,226	15·324	12·50
14.	287	3·412	11·89

VILLAGES—Stratum III (*Population 2000—5000*)

1.	1,500	24·635	16·42
2.	3,462	56·745	16·39
3.	2,170	36·573	16·85

APPENDIX 4

Block and village-wise data for 'active' and 'probably active' cases (contd.)

V—Patna Zone

Block or Village No.	Number x-rayed	Active and probably active cases		Block or Village No.	Number x-rayed	Active and probably active cases	
		Estimated Number	Rate per 1000			Estimated Number	Rate per 1000
	CITY			28.	755	16·923	22·41
				29.	855	17·224	20·15
1.	745	10·238	13·74	30.	505	9·027	17·88
2.	755	16·280	21·55				
3.	720	19·720	27·39		TOWNS—Stratum I (*Population 10,000—20,000*)		
4.	710	13·623	19·19				
5.	470	5·236	11·14	1.	325	11·237	34·58
6.	725	9·643	13·30	2.	870	16·968	19·50
7.	680	7·682	11·30	3.	635	12·747	20·07
8.	740	9·943	13·44	4.	650	10·279	15·81
9.	845	11·692	13·84	5.	210	4·052	19·30
10.	610	9·884	16·20	6.	510	10·580	20·75
11.	455	9·724	21·37	7.	1,250	24·454	19·56
12.	360	7·863	21·84	8.	575	5·223	13·93
13.	345	9·653	27·98	9.	285	10·912	38·29
14.	340	7·406	21·78	10.	450	10·273	21·40
15.	280	10·843	38·73				
16.	245	6·368	25·99		TOWNS—Stratum II (*Population 20,000—50,000*)		
17.	405	12·623	31·17				
18.	510	4·029	7·90	1.	440	10·553	24·07
19.	495	9·979	20·16	2.	255	1·979	7·76
20.	225	6·188	27·50	3.	355	9·483	26·71
21.	170	1·798	10·58	4.	340	10·924	32·13
22.	345	10·587	30·69	5.	670	20·007	29·86
23.	340	12·564	36·95	6.	335	1·856	5·54
24.	290	7·799	26·89	7.	375	2·655	7·08
25.	280	10·884	38·87	8.	905	13·217	14·60
26.	220	4·135	18·80	9.	335	4·420	13·19
27.	550	11·697	21·27	10.	280	8·399	30·00

VILLAGES—Stratum I (*Population less than 500*)

1.	365	6·127	16·79
2.	555	12·806	23·07
3.	965	14·462	14·99
4.	475	8·707	18·33
5.	180	4·817	26·76
6.	225	5·120	22·76
7.	165	3·148	19·08
8.	230	4·039	17·56
9.	245	4·597	18·76
10.	110	1·173	10·66
11.	25	0·078	3·12
12.	25	0·117	4·68
13.	290	3·626	12·50
14.	290	4·049	13·96
15.	120	2·763	23·03
16.	250	3·456	13·82
17.	180	5·024	27·91
18.	90	2·808	31·20
19.	275	5·838	13·96

VILLAGES—Stratum II (*Population 500—2,000*)

1.	700	18·743	26·78
2.	560	7·711	13·77
3.	580	8·271	14·43
4.	815	15·023	18·43
5.	1,520	23·442	15·42
6.	440	8·346	18·97
7.	400	3·990	9·98
8.	820	8·329	10·16
9.	530	7·547	14·24
10.	575	14·763	25·67

VILLAGES—Stratum III (*Population 2,000—5,000*)

1.	1,820	22·238	12·22

APPENDIX 4

Block and village-wise data for 'active' and 'probably active' cases. (contd.)

VI—Trivandrum Zone

Block or Village No.	Number x-rayed	Active and probably active cases	
		Estimated Number	Rate per 1000
	CITY		
1.	240	6·416	26·73
2.	550	7·199	13·09
3.	250	5·083	20·33
4.	335	4·041	12·06
5.	375	7·125	19·00
6.	785	15·930	20·30
7.	375	6·196	16·52
8.	385	8·122	21·10
9.	535	8·572	16·02
10.	655	11·980	18·29
11.	265	3·904	14·73
12.	380	6·319	16·63
13.	925	16·985	18·36
14.	630	10·702	16·99
15.	365	3·073	8·42
16.	475	3·258	6·86
17.	1,250	18·040	14·43
18.	605	12·607	20·84
19.	425	2·914	6·86
20.	470	7·711	16·41
21.	670	12·126	18·10
22.	345	5·875	17·03
23.	500	6·844	13·69
24.	370	8·988	24·29
25.	355	3·885	10·94
26.	425	3·523	22·41
27.	330	5·356	16·23
28.	610	9·629	15·79
29.	330	7·073	21·43
30.	420	6·686	15·92
31.	325	6·801	20·92
32.	815	12·635	15·50
33.	445	2·596	5·83
34.	450	7·600	16·89
	TOWNS—Stratum I (*Population 10,000—20,000*)		
1.	315	6·577	20·87
2.	220	10·041	45·65
3.	205	6·933	33·81
4.	225	2·971	13·20
5.	35	2·522	—
6.	100	2·116	21·16
7.	120	4·310	35·91
8.	210	4·548	21·66
9.	70	1·555	22·21
10.	235	1·988	8·46
11.	345	7·232	20·96
12.	160	1·698	10·61
13.	385	5·642	14·65
14.	420	8·346	19·87
15.	380	7·550	19·87
16.	500	9·538	19·07
	TOWNS—Stratum II (*Population 20,000—50,000*)		
1.	320	5·362	16·76

2.	380	5·632	14·82
3.	400	6·600	16·50
4.	500	8·822	17·64
5.	165	4·130	25·03
6.	280	5·594	19·98
7.	325	13·673	42·04
8.	200	4·526	27·63
9.	395	12·624	31·96
10.	705	10·513	14·91

VILLAGES—Stratum I (*Population less than 500*)

1.	140	3·087	22·05
2.	190	1·257	6·61
3.	285	0·516	1·81
4.	300	2·324	7·75
5.	200	9·623	48·12
6.	240	8·274	34·48
7.	110	4·926	44·78

VILLAGES—Stratum II (*Population 500 to 2000*)

1.	490	7·887	16·10
2.	1,270	18·189	14·32
3.	1,160	15·847	13·66
4.	1,295	22·066	17·04
5.	1,050	9·477	9·03
6.	540	10·584	19·60
7.	360	2·122	5·89
8.	835	20·262	24·26
9.	880	5·813	6·61
10.	950	11·916	12·54
11.	735	12·975	17·66
12.	1,630	27·403	16·81
13.	1,240	13·645	11·00
14.	720	13·094	18·19

VILLAGES—Stratum III (*Population 2000—5000*)

1.	2,200	17·921	8·15
2.	1,795	26·773	14·92
3.	1,810	30·929	17·09
4.	2,085	27·404	13·14
5.	5,280	53·730	10·18
6.	2,085	32·515	15·59
7.	3,060	53·343	17·43
8.	3,715	50·038	13·46
9.	2,150	53·991	25·11

APPENDIX 5.

FIELD WORK—INTERESTING SIDE-LIGHTS.

Extracts from a team leader's diary.

Finished work at 8-30 p.m. During these 4½ hours 301 persons were examined. Dr. Vermani and I with some other persons left at 9-00 p.m. for the rest house while the vans started for the Municipal Office via the Circular Road.

At 9-45 p.m. Sharma came in a Riksha. I had hardly finished taking my bath. The news was that the *x*-ray van had turned turtle. Dr. Vermani and I left in all haste. We collected his chief sanitary inspector and two more persons and reached the spot. There was a breach on the road by the side of a tank. On one side of the road was the tank and on the other a Nulla. The *x*-ray van was tilted over at an angle of 75 degree. The right side wheels were stuck in the mud and the left side hind wheels were 5″ clear of the ground. It looked as if the van would completely turn over as the water was still flowing and eroding the road. Some genius of a person suggested stopping the flow of water. A 4″-5″ high mud 'wall' was made along the length of the tank and water prevented from flowing across the road any further. There were, besides our men, each in mud and water but helpless, several of Dr. Vermani's staff. The tractor driver was dead drunk, and therefore, not available. No rope or chain strong enough was found. But we were taken to a gem of a man—Sohan Lal—a member of the Municipality—a practising compounder, I understand. People obeyed Dr. Sohan Lal. He collected a number of them and got a a tug-of-war-rope—entirely his own idea—from the local High School.

We got the rope and reached the place of accident at 11-00 p.m. Another truck had come and many villagers had come to help already. Dr. Sohan Lal's requisitioned truck got stuck on the way and reached at nearly 11-30 p.m. Three big logs of wood had been procured. Bricks torn from the road were put underneath, the rope passed round, and pulled. There was no effect. Anyhow with the arrival of the stuck-up truck, and a party of police-men, a log of wood was stuck in the half visible rim of the hind wheel. Simultaneously the rope was pulled. The van rose 3″-4″ only to sink again. Now jacks were applied to the bumpers but bricks placed below the jacks would sink in the ground. More bricks were placed. With jacks on, pull of the rope and leverage of the log of wood, the van was raised again. Engine was started and with a mighty noise and many cheers it regained the road—time was 1-45 a.m. and each one, a practical exponent of the 'philosophy of dirty hands' and feet too.

We took our meals at 2-15 a.m. and were back at work at 9-30 instead of the scheduled 8-00 a.m.

Rains and floods in Punjab

It has been raining almost continuously. A good few inches of rain would have fallen. Last evening there was some 6″ of water on the road inside the Rest House. Outside the drizzle is off and on and varies in intensity with the elements, but inside it is a steady drip in bigger drops, continuous during day and night.

On the evening of 4th October 1955 there was some 6″ of water on the road in the rest house. The vans were standing on one of the side-roads inside the rest house and by its side the jeep. At about 12 midnight the attendant who was occupying one for the servant's quarters in the rear came in and told that water had come into his room. There was no light in the Rest House and I could not read the time in my watch due to pitch darkness.

I thought the vans and the car should be taken to the G. T. Road, as the water was rising at a rapid rate. The attendant was sent to the Marketing Office to get the drivers. He had to walk through knee-deep water without the help of any light. At 3-30 a.m. or so Mr. Sharma and the three drivers came. With the help of the lantern light a struggling form (a snake ?) was made out in the water. Within this half an hour water had risen half a step more.

With the first glance of a doubtful dawn, with the help of the Chowkidar and our drivers and Mr. Sharma, the small car was pushed on to the G. T. Road, by this time water had risen all the 3 steps of the Rest House and was 2 inches deep in each room. The engine was started. The fan sprayed water all over and almost immediately after start, the engine stopped. It was decided to push the vans on to the G. T. Road. There was no other alternative. The rest of the team were summoned and each one pushed and pulled at the Generator van in waist deep water. The van got stuck on a soft patch . It was puhsed back again to original position and again pushed towards the road. It was pushed as far as possible and left there. After a few minutes the engine was restarted. It started again and at full throttle, in power gear, the van went up the Road. Similary the *x*-ray van. By this time it was 8-00 a.m. water was still rising. By 10-00 a.m. it was to be 18 inches in each room of the rest house. Once on the road and with all my luggage out, the vans were examined. No damage and they were road worthy.

The jeep was started. It did start but stopped immediately and would not start again. Mobil oil was let out, there was more than a gallon of water on top of which this oil was floating. New mobil oil was put in. Yet the engine did not start. It was decided to let out the petrol, filter it or put in new petrol. At last the jeep was pushed to a workshop. All workshops were under water. The screw was somehow unscrewed, petrol filtered through chamois and the carburetter cleaned etc. The jeep became road worthy. What a relief that our vans were not washed off in the floods !

Stories from South

Extract from field reports

The display of the huge *x*-ray van in the Block, the buzz of the generator and the click of the Radiographer are enough attraction and a convincing curiosity shop for the public to respond generally. But the approach of the Bacteriologist to pick out a few of the *x*-rayed, with display of suspicious cards, for a manoeuvre in their throats, is enough scare in the block to resist our investigation particularly from those who are physically fit. It requires all the tact and tenacity on the part of the workers in the field to evoke a good response.

In areas where a large number of persons examined belonged to the Muslim community, we had to make house visits for collection of specimens in various localities and in one case, we had to train the husband to take the laryngeal swab of his wife.

Since the Pilot Survey in June 1955 the monsoon did great damage to many of the village roads and in many places the *x*-ray van could move with great difficulty only. In Tumkur District the original road to Naganaballi village was a lorry track, tolerably good. When the *x*-ray unit reached there, the whole road was washed away, rutted, and even encroached by cultivation. It is praise-worthy that in response to our appeal about 60 villagers voluntarily relaid the road within one day and the *x*-ray van could move right into the village.

At another place a cart track to a village was widened—a distance of about 5 miles from the main road.

On October 20, 1955 the *x*-ray van got stuck in the night at 22·00 hrs. on the way to Reddipalle, Cuddapah District, in the middle of the one-mile-wide Pennar River. Some of the staff slept in or around the van guarding it. The next morning 14 pairs of bullocks were engaged to drag the *x*-ray van up.

Another time at Muthyalpad the *x*-ray van sank into sandy road. A trench had to be dug, paved with stones, and the *x*-ray van towed up with the Jeep, assisted by 50 people who pushed and pulled.

The fear of a needle prick was strong in the minds of many and the sight of a laryngeal swab occasionally caused great agility in old people who had been too decrepit to move before and they had to be pursued and be persuaded that there was no needle.

Instruction had to be given as to what was 'sputum' not just saliva. In villages the whole population became interested. In one place, a sick man had to be visited

in his hut as he was not well enough to come to the village centre. His first attempt at spitting produced only saliva and the rest of the village who had learnt what was wanted frowned on him with disapproval. So he had to try again and the real stuff came up this time and people lifted up their hands and cried "AH" in approval. He had done his duty well !

Interesting public reactions

Off to the Jungles.—At one place, Daltonganj, many houses were found vacant and people had run away to local jungles. On equiry it was gathered that only recently a census of young adults was completed and they feared military recruitment. They returned after a few days, when they came to know the real objective.

The "Wrestler" and his "Prisoner".—In one place a person refused to come for examination or send his wife or children for the same, although the *x*-ray van was within 50 yards. (or less) from his house. He warned our personnel that if any one entered his house he would be doing so at his own risk and the consequences would be extremely serious. The Sub-divisional magistrate of the place, however, persuaded him to come for *x*-ray. Thus he came to the *x*-ray unit in the evening ; this 6 feet tall broad man, challenged to wrestle with any one who would even think that he had anything like tuberculosis in his chest. Ultimately he and his two children were *x*-rayed, but not his wife. He declared that during the seven years of his married life, his wife had never come down from the 1st floor. If she ever did so, he was prepared to murder her. Further efforts to get the lady *x*-rayed were given up.

Mother-in-law's heroic sacrifice.—Once when a family consisting of a mother-in-law, daugter-in-law and an infant in-arms, was being persuaded to get *x*-rayed, the old mother-in-law said to her daughter-in-law, in pathetic tones, "Look I am going for this and if I do not come back you leave this place and take to the jungles. God will take care of you".

Public anxiety.—A great difficulty was the continuous questions from thepublic about what would happen if they were discovered to be suffering from tuberculosis : who would treat them ; whether they would get help who would look after the family ; would they be put in isolation camps ; would they be considered as outcastes in their society ?

Customs and prejudices.—Purdah system was a very great hindrance for the survey work. In villages with strong purdah practice special arrangements were made such as making enclosures of cloth so that ladies could move into the *x*-ray van from a nearby house or veranda without being visible to the public. Some strict purdah observers did not come for *x*-ray even after these arrangements were shown to the male members of their family. Whereas the orthodox muslims wanted

lady technical personnel in some other communities matured girls were forbidden to come to public places before their marriage.

Some of the Muslims refused to come for *x*-ray as the Koran forbids portraits. Most of them were persuaded by explaining that an *x*-ray photo was not a portrait but only a shadow picture of the chest.

Strange views and expectations.—Some persons wanted "group *x*-rays photo", whereas some other wanted copies of the *x*-ray photo.

Some persons believed that the survey work was being carried out for the object of birth control as the family planning schemes were not successful.

Some persons brought their wives who were in full term of pregnancy for finding out the sex of the child that would be born, by means of *x*-ray.

Some people came for *x*-ray of different parts, specially of head and pelvic region to find out the cause of mental deficiency and impotency respectively.

Some educated persons were scared to come for *x*-ray under the impression that taking an *x*-ray photo will cause harmful effects on the body.

Some people thought that if they came near the *x*-ray van, they would catch tuberculosis.

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